FINAL ENGINEERING REPORT
FOR
SURVEYOR EJECTA DETECTOR
MODEL ML 256-1 AND 185-1
AND
SURVEYOR EJECTA DETECTOR
GROUND SUPPORT EQUIPMENT
MODEL ML 260-1

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ABSTRACT

The following is the Final Engineering Report on the Surveyor Ejecta Detector (ML 256-1 & ML 185-1) and the Ground Support Equipment (ML 260-1) for this experiment. This equipment was designed, developed and fabricated by Marshall Laboratories under National Aeronautics and Space Administration Contract No. NAS 5-3417.

The objective of the experiment is to measure momentum, energy and direction of particles, close to the lunar surface, were built on an exposed rectangular plate. In general, these particles will be secondary particles which are emitted from the lunar surface when a primary particle impacts.

Goddard Space Flight Center personnel and Marshall Laboratories jointly designed the basic sensor plate. Goddard Space Flight Center was then responsible for supplying the thin film s and acoustic transducers for the sensor while Marshall Laboratories was responsible for fabrication of the sensor plate. Marshall Laboratories was also responsible for building the sensor electronics package (ML 256-1) and the electronics in the main body of the spacecraft (ML 185-1). The Marshall Laboratories electronics packages performed the following functions:

1. Amplify the sensor signals and convert them into a binary form which is compatible with the spacecraft telemetry system.
2. Storage of data until a new impact occurs and counting of acoustic signals and film signals.
3. Supply in-flight calibration signals.
4. Convert spacecraft power into various regulated voltages.

The electronic units were constructed of welded modules which were interconnected by means of a welded matrix. Soldered wires connected the matrices to connectors on the housings. Three complete prototype units and one sensor thermal unit were build.

Two GSE units were built with the following functions:

1. Simulate all spacecraft power and signals.
2. Provide simulated impact signals to sensors.

3. Provide visual display of experiment outputs.

4. Be capable of operating on external batteries.

Wherever possible, welded modules and welded matrices were used with soldered interconnections employed between matrices and other components.

In addition, three battery operated calibration units were supplied. These units can be plugged into the sensor electronics when the experiment is on the spacecraft and supply five additional calibration signals to the experiment.

All units were successfully built, tested and calibrated. Test data is included in the report.

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INTRODUCTION

This final engineering report is submitted in partial fulfillment of NAS 5-3417 for the Surveyor Ejecta Detector which was designed and built by Marshall Laboratories for the Goddard Space Flight Center. The Ejecta Detector is a scientific instrument which will become an integral part of the Surveyor Lander Spacecraft which will be landed on the surface of the moon. The objectives of the contract were to design, fabricate and test four units of electronic instrumentation for dust particle detection; to design, fabricate and test two units of Ground Support Equipment; and design, fabricate and test three battery operated calibrate units. Finally, to give support necessary to integrate electronic units, and to provide documentation on the above units.

This report discusses the design philosophy and presents the detailed engineering analysis of the Ejecta Detector and Ground Support Equipment. It discusses the test results of the flight qualified prototype instruments, and includes those illustrations and documents necessary for a thorough understanding of the instrument and its associated ground support equipment.

FUNDAMENTALS

This instrument is designed to measure the characteristics of the particles of mass ejected from the lunar surface as a result of primary meteroid bombardment from interplanetary space. These pieces of lunar surface material which are ejected upon impact of a primary particle are expected to be more numerous, than the primary particles and have ballistic trajectories which, it is postulated, will cause a significant flux of secondary particles near the surface of the moon.

Since the mass, velocity, and number of these particles is of extreme importance in considerations of future lunar landings, and of general interest to the scientific community, it is apparent that the first instrument landing on the moon will provide an opportunity to measure these particle fluxes and accumulate scientific statistics on their abundance and significance in the lunar environment.

The instrument sensor consists of two different types of detectors, an acoustical sensor which has an output proportional to, or related to, the momentum of the particle, and a thin film capacitor detector. The acoustical detector consists of a planar metallic plate which will be oriented normal to the surface of the moon. Impacts on the plate will result in acoustical transmissions which will be sensed by a acoustic transducer mounted in the center of the plate. On both sides of the acoustical detector plate are deposited thin film capacitors. The impinging particle momentarily shorts both sides of the capacitors together causing a reduction in the potential difference across the plates of the capacitors and a redistribution of the charge which is sensed in the input amplifier and yields information regarding the particle energy. The momentary flow of charge through the shorted part of the capacitor causes the short to burn-out immediately thereby enabling the sensor to receive new impacts. The exact relationships between the particle mass, velocity or momentum for the particular sensors used in this experiment are determined for each instrument at, by hypervelocity tests using particle accelerators, one of which is located at Goddard Space Flight Center. The directional sensors are the capacitors which are deposited on each side of the acoustical plate, and electrically isolated. The direction from which the particle has originated is sensed by identification of which side of the plate was hit, by means of the two capacitor sensors.

The processing of the signals from the acoustical sensor and two capacitors is provided in an electronics assembly located directly under the sensors and in an inboard electronics unit located in Compartment B within the Surveyor spacecraft. The processing of the two types of signals include a pulse height analysis to determine the momentum and energy parameters, and a counting of particle events as well as identification of which of the capacitor sensors was activated thereby determining the direction of the impact. The data collected is stored in binary form and immediately transmitted in a serial readout pattern to the spacecraft telemetry system. Thus a readout occurs for every change in the status of the data. The accumulation of data which may occur during a readout is also provided, since the readout interval may be significant compared to the expected data rates of the ejecta flux. This accumulation of data after a readout has been initiated consists of the counting of particles which have been sensed by the acoustical detector and the counting of particles which have been sensed by the two capacitor detectors. These totals are stored in separate accumulators and are provided because of the probability that the meteor flux will be in the form of concentrated bursts of many impacts at one time. The experiment performs a pulse height analysis on the event which initiates the readout, and during the readout records all subsequent impacts in the accumulation portion of the experiment only.

The other functions of the electronics are to provide operating power to the electronics from the spacecraft central power supply, to provide a means for in-flight or on-the-surface-of-the-moon calibration of the sensor channels, to provide a means for sending a repeated data transmission upon receipt of a readout command from the central spacecraft telemetry system, and provide a capacitor film clear signal to the capacitor sensors, in the event a particle has caused a short in these sensors which has not self-healed. This sensor short may be "burned-out" by a command from the central spacecraft telemetry system which will provide the current necessary to burn out the shorted capacitor thereby making the capacitor sensor operable again.

The initiation of a readout upon impact of a particle can be due to either a capacitor sensor signal or a acoustical sensor signal, but once such a signal has occurred provision has been made to restrict the pulse height analysis to only that initial impact. This restriction insures that the pulse height analysis and thereby the mass and velocity parameters which have been derived from the acoustical sensor will be on the same particle as that derived from the capacitor sensors. Simultaneous solution for mass and velocity on a single particle is possible. In the event that simultaneous solution for the individual parameters is not necessary, this restriction insures a redundancy in the analysis which may prove to be valuable in assessing the confidence level of the results of this experiment. For brevity in the rest of this discussion, the acoustical sensor will be termed "mic" or microphone and the capacitor sensors will be termed "film".

EXPERIMENT DESCRIPTION

The photographs of Figures 1 and 2 show the Ejecta Detector in its final flight configuration. In Figure 1 the sensor plate and the microphone are in the rear. The capacitor sensor is divided into two sections which are separated by a web which supports the microphone. The electronics housing is located immediately under the sensor plate and supports two Cannon connectors which are jutting out to the left.

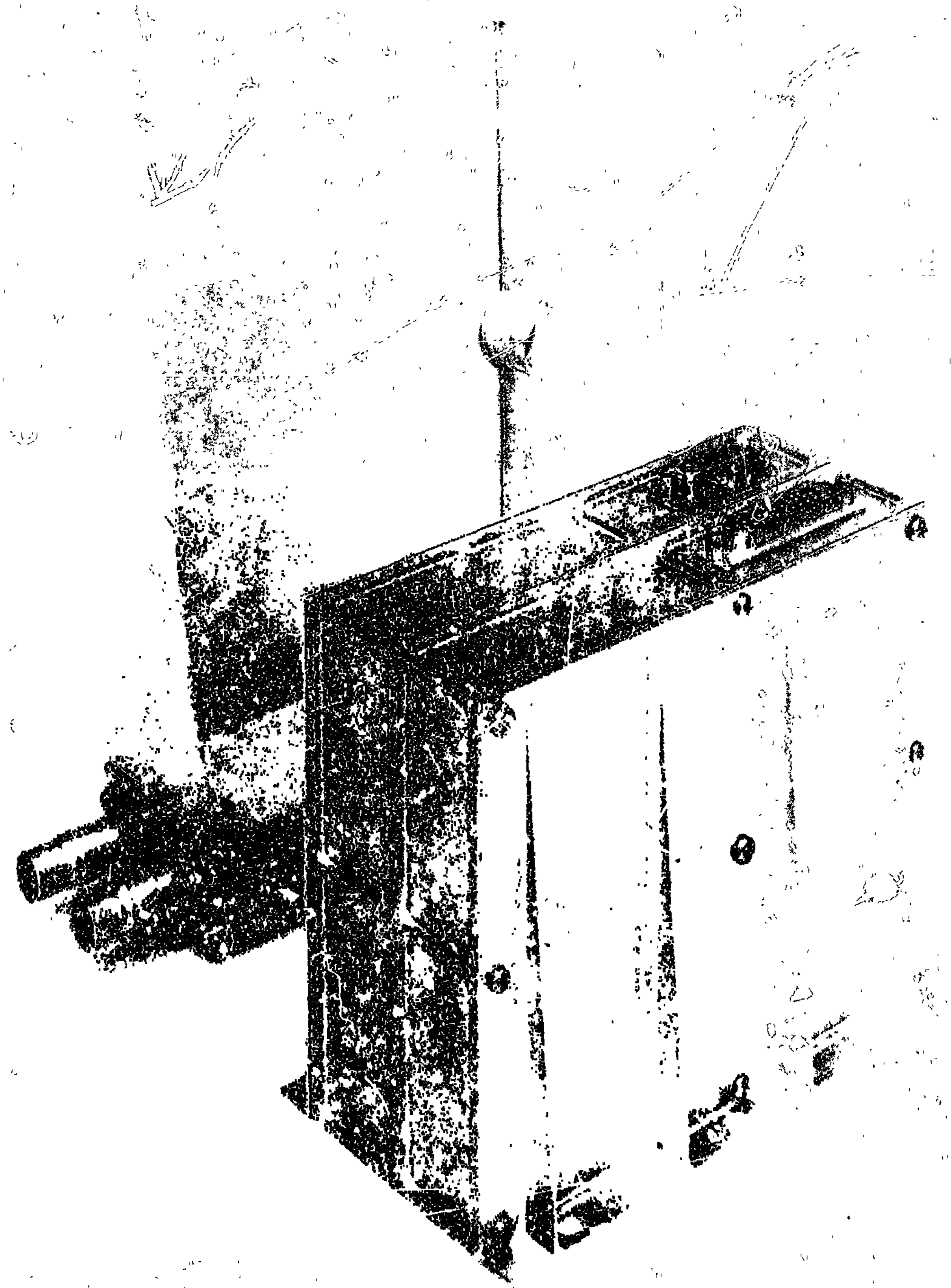


Figure 1. Ejecta Detector Experiment

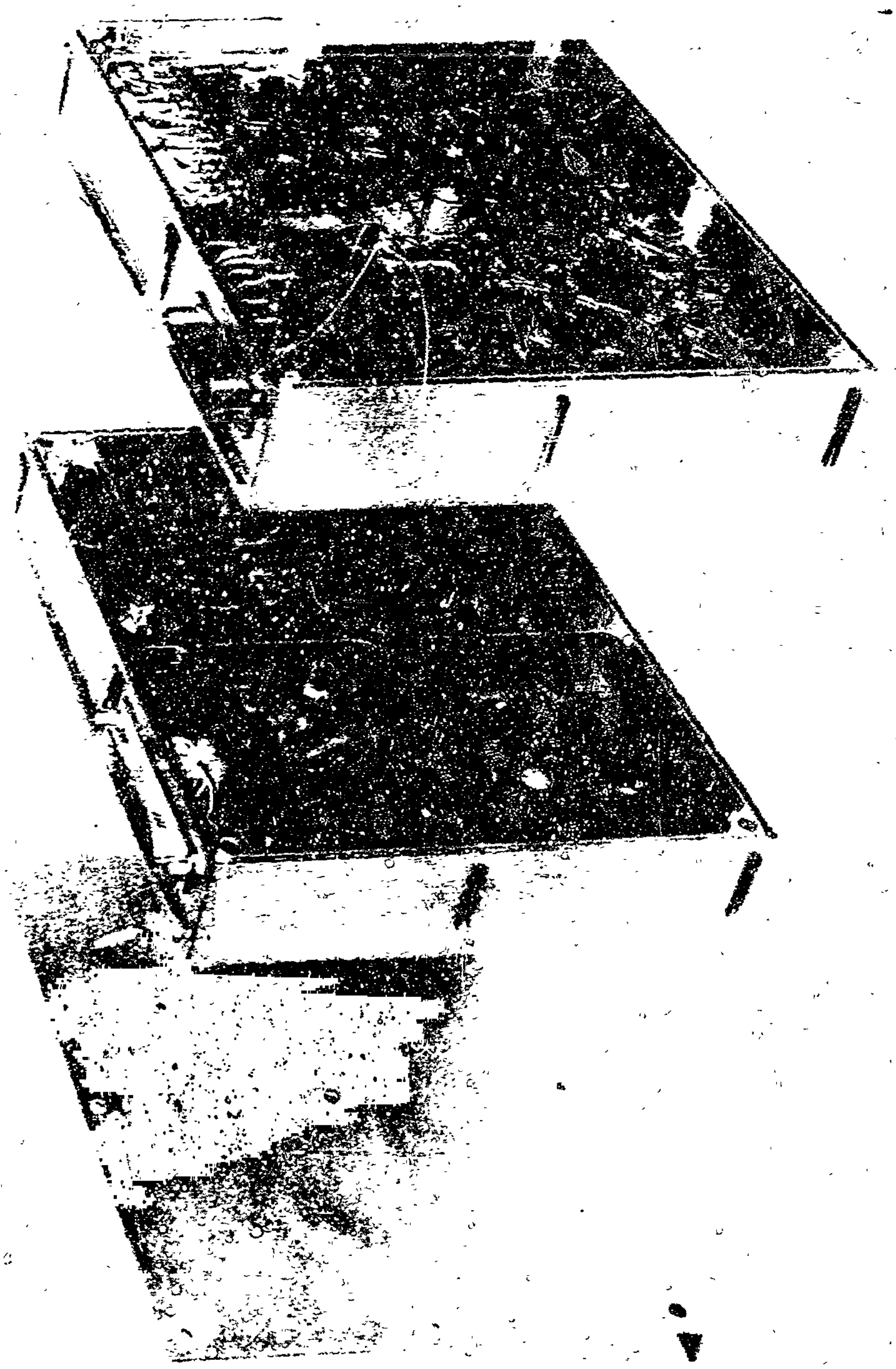


Figure 2. Ejecta Detector Blivets and Covers

In the foreground is the inboard electronics package containing most of the digital circuitry for processing the data from the sensor electronics package. In the spacecraft these two units are separated by a seven foot length of cable. Since the sensor plate is exposed to the direct rays of the sun, the temperature extremes in the sensor electronics and on the sensor plate is expected to be quite different from those of the inboard electronics which is in a temperature controlled chamber.

The photograph in Figure 2 shows an exploded view of the inboard electronics. The covers being removed, exposing to the rear the power supply electronics which contains the low voltage power converter and regulators and the telemetry coding circuitry and command interfaces required to condition the signals before transmission to the central spacecraft. The connector at the top is the spacecraft cable connector and that on the side is the interconnecting connector to the housing in the foreground (Digital) which contains the pulse height analyzer circuitry as well as the data storage and accumulation registers. The connector at the top of this housing is from the sensor unit. The schematic diagram of the three units discussed: the sensor electronics, the digital housing and the power supply are shown in Figure 3. (ML Schematic Diagram No. 51114 sheets 1 and 2) Here, Sheet 1 is the sensor electronics and Sheet 2 is the inboard electronics; To the left is the digital portion, and to the right is the power supply portion. The connector on the far right is the interface between the spacecraft and the Ejecta Detector.

First, let us follow the signal flow through the two diagrams in a very brief manner, so that the reader may be oriented as to the functions of each major group, and as to the locations within the diagrams of each function. Consider first the acoustical detector, which we had decided to term "mic". As you see, the microphone input is on the upper far left of the first sheet of the schematic diagram and is directed to a four-stage amplifier consisting of modules Z1 through Z5 and finally a conditioning emitter follower Q1. The output of this amplifier which has the individual stages with gains of 10 each and a bandpass filter which limits the frequency response to a 10 KC band around 100 KC, the natural frequency of the crystal sensor. The output signal of the composite amplifier is called the microphone signal, and if we go to the next sheet you will find it entering on Pin 1 of the left hand connector, and being applied to a detector.

This detector is a differential feedback detector. The output of the detector eventually follows the peak of the incoming signal - a modulated carrier of 100 KC - the envelope reaching peak within 10 cycles of the carrier. The output of the detector is applied to the gain of two amplifier, which is shown to the right of the detector, and from the gain of two amplifiers the signals are threshold detected in the differential comparator stages Z45 and Z44. These comparators detect if the signal is above or below threshold and thus control and gate, Z43, which gates astable mutlivibrator Z42 to generate the pulse height to pulse count conversion which is stored in accumulator Z28, Z27, and Z26. The greater the number of pulses stored in this accumulator the greater is the height of the pulse. The status of the accumulator is available on lines to the immediate right of the three accumulator binaries and is the data labeled MPHA 1, 2, and 4. This data is then made available to the right most portion of the schematic which will sample the d-c levels and transmit them as ones or zeroes as the telemetry sequence progresses.

The sequence of readout is determined by the sequencer counter Z13 through Z17 and the dual nand and dual parallel nand gates Z2 through Z11. The resulting serial readout word is applied to the SCO driver, Z1, which conditions the levels of the readout word to be compatible with the spacecraft telemetry circuits. The output of this module to the telemetry is normally, in the absence of data, a square wave having a one hundred-cycle-per-second frequency. When data is present in the system, a code address 001 is transmitted in a return-to zero fashion whereby the pulse height and accumulator bits are transmitted. The total number of bits transmitted including code address is 19. The 100 cps signal originates at the 100-cps clock which is an astable multivibrator, Z24. This clock serves the dual function of telemetry waveform generator, and a continuous reset generator when data is not present. The clock is used to strobe the condition of gates Z2 through Z11 during the readout sequence. The other input to these gates are the signal data which are available from the bistable multivibrators in the digital portion, of which only the mic PHA storage binaries have been discussed.

Return to Sheet 1, the sensor electronics schematic, and trace the film signals as they pass through the electronics to the telemetry system. On the left had side of the schematic we see the inputs Film A and Film B being applied to separate modules Z7 and Z8. These are high-gain amplifiers with a gain of approximately 50 db which amplify signals to usable levels at low impedances which can be transmitted on the cable as the Film Signals A and B. If we go to Sheet 2 we will see these signals appearing to the lefthand portion of the schematic as Film A and Film B. These lines are applied to differential feedback detectors Z58 and Z59 which constitute the beginning of the A and B channels of the film pulse height analyzer. The outputs of the detectors are respectively applied to comparators Z59 and Z67. These comparators control and gates Z62 and Z64 which, in turn, gate the clock pulse generator Z63 which performs the pulse height to time conversion. The data thus accumulated in the film pulse height analyzer is stored in bistable multivibrators Z32 through Z35. The outputs, labeled PHA 1 through 4, are d-c levels which are sampled by the telemetry conditioning section.

The readout of data to the telemetry system can be initiated by the occurrence of either a microphone or one of the two films. The occurrence of either of these signals is sensed by module Z70, dual nand gate which has as its output the beginning of readout line which initiates the telemetry cycle. The Beginning of Readout line triggers bistable multivibrator Z20 to enable the dual nand gate Z19 to allow clock pulses to strobe the nand gate chain Z2 through Z11. Since Z2 through Z11 dual nand gates have inputs from the bistable multivibrator countdown chain, Z1 through Z5, the nand gate which will be completely enabled is determined by the status of this countdown chain. This nand arrangement, module Z2, and Z11 form a NOR output gate from which the data are directed into the SCO Divider. When the readout is completed, a detect 20 circuit which is part of Z18 detects this fact and resets various circuit functions so that new pulse height data can be received.

If an In-flight Calibrate Command is generated within the spacecraft telemetry system, the command signal will be routed to the command interface module Z77 and from there to the sensor electtronics section where the in-flight calibrate command sequence has begun. If the spacecraft generates a Readout Command signal, the command is directed to module Z23 and modules Z23 will set bistable multivibrator Z20 in the same manner that the beginning of readout sequence is initiated by the occurrence of a particle impacting either of the sensors. If the sensor telemetry system generates a Clear Command, this command is directed to module Z78 which generates a pulse which is also sent to the sensor electronics section where the needed current to clear the film sensor is generated.

The power for the detector electronics is derived from a +29 v regulated d-c source available in the spacecraft through a module Z81, a d-c to a-c invertor which is based on a design that originated with J. L. Jensen in an article "An Improved Squarewave Oscillator Circuit", in the IRE transactions on Circuit Theory, C.T. -4, 276-277 Sept. 1957. This convert r has an oscillator transformer T1 and a voltage conversion transformer T2. The output of the voltage conversion transformer occurs on four secondary windings from which the +12, +6, +3 and -7 volts are generated. In the case of the +3 volts and the +6 volts, synchronous rectifiers are used and in the case of the 12 and -7 volts feedback differential regulators are used. The outputs of each of the detector lines are filtered by the meansof tantalum capacitors and are further filtered in critical areas hence, noise pickup is minimized throughout the system.

Incorporated in this unit is a fail-safe system whereby if by some chance the films become noisy and generate pulses of sufficient amplitude to trigger the system erractically, this rapid data rate is sensed, and the films are disabled from starting a readout. This is accomplished in modules Z74 and Z75 and Z76. Z74 and Z75 constitute an integrating trigger circuit which senses the data rate of the film and if the data rate exceeds a preset value,the initiation of readout by the films is disabled through gate Z76.

We have now very rapidly scanned the high-lights of the Ejecta Detector. Let us now go back and examine each portion of the circuitry and discuss, in some detail, the operation involved. We shall begin with the microphone signal as it enters the sensor electronics. We shall then examine the film signals as they enter the sensor electronics and are converted to digital form. We shall see the origin of the Beginning of Readout pulse and the mechanism whereby readouts are initiated. We shall examine in detail the method of presenting the data to the telemetry in serial form and finally we shall investigate the various calibration and command sequences which form the peripherial part of this data processing.

Refer to sheet one of the schematic diagram of Figure 3. The microphone signal is a 100 KC modulated envelope. The first peak of this signal will occur between 3 and 10 periods of the 100 KC carrier. Since reflections are expected from the microphone due to the finite distance from the microphone to the edges, or discontinuities in the plate, and since it is undesirable to peak detect on these reflections, it is necessary to inhibit the detector from further peaking after the first sampling period which is determined to be 100 microseconds, or 10 periods, the inhibit being effected in the detector circuit. The inhibit lasts for 30 milliseconds and occurs by the action of the inhibit-and-hold module, W4168, Z47, which effectively shorts the emitters of the differential amplifier in the differential feedback detector to B+, thereby back biasing the differential feedback detector. Schematics of the detector and the inhibit-and-hold module are given in Appendix A. The inhibiting action is initiated by the 30 millisecond one shot, Z49. This one shot is triggered by the trailing edge of one shot Z50 which occurs immediately after the comparator, which is biased at 250 millivolts, reaches threshold.

When the comparator changes state, due to the fact that the signal has reached threshold, the output of the comparator, Pin 12 of Z44 triggers one shot Z50. A schematic diagram of the comparator module Z45 and Z44 is also given in Appendix A. The detector and comparator circuits were developed to withstand the extreme environments expected in the lunar landing. Tests have been run on these circuits which show them to be stable within a millivolt under extremes of temperature with wide dynamic ranges available. The circuits consume very little power and will operate at reasonably high speeds. The detector is a closed-loop amplifier with a diode rectifier in the feedback loop making the feedback unilateral. The output is taken off the feedback point such that the input will follow the output. Across the output is a capacitor of .047 μfarad which is used to smooth the signal peaks.

At the time of the incidence of the signal, the resistors R7 and R16 is not returned to ground due to the holding action of module Z47. This action is initiated by the output of Z50, Pin 6, the 100 μsecond one shot, thereby the holding interval - the interval in which the capacitor is maintaining its charg , or adding to it, is 100 μseconds. At the end of 100 μseconds interval, the holding signal is released and the resistor R7 and R16 are returned to ground thereby discharging the capacitor. The rate of discharge is μseconds time constant, and provides the logarithmic time base for the pulse height to time conversion. The time difference between the time at which the signal originally passed the threshold on the comparator to the time at which the decaying pulse again passes threshold is the time allowed for the generation of clock pulses in the accumulator of the pulse height analyzer.

The gain of 2 amplifier is used to enable a wide dynamic range on the comparator while limiting the detector dynamic range to quite reasonable figures, thereby limiting the amount of charge necessary for the capacitor and hence the current demand of the detector. The comparator threshold is established by resistors R8 and R9, nominally 250 millivolts. The dynamic range of the comparator in this application is approximately 20 to 1. The maximum number of clock pulses generated in this circuit is 7 after which the detector and amplifiers preceeding the detector saturate so that the maximum count for expected particle ranges is a 111 and the mic PHA storage binaries. The initiation of clock pulses occurs when the 100 microsecond one shot returns to its initial state after a delay of 100 μseconds. At this time the comparator output Pin 7 Z44 is up and allows this positive-going-one-shot pulse to start the clock. The uncertainties due to pulse shape in the microphone signal have been eliminated in that the clock always starts on a very rapid rising edge of the 100 μsecond one shot. The comparator, returning to its original state after the time decay in the detector, shuts the clock off and therefore the pulse height pulse/count conversion is accomplished. The and gate Z43 establishes the inhibiting of the pulse height analyzer provided no mic hit has occurred, or inhibits the analyzer after one hit has occurred. This action is accomplished through gates Z52 and through the one shot Z53 and bistable multivibrator Z51. If a readout has been started by the film the data reset line will be actuated immediately setting bistable multivibrator Z51 to the enable state 3 and 5 going to a 1 enabling and gate Z43. It also accuates one shot Z53 which inserts a negative going signal on Nand gates Z52. The output of this Nand gate is the inhibiting lead and if the comparator Z44 is still up and has not been processing data in the analyzer, the trailing edge of the one shot will get through the Nand gate and trigger the bistable multivibrator to inhibit further data analysis after the one hundred µsecond interval of Z53. If data is in-process in the microphone pulse height analyzer.

If data is in-process in the PHA NAND gate Z52 will be inhibited, therefore the action of one shot Z53 is also inhibited. Z53, Pin 8, the output of the one shot, will return to the one state. At the conclusion of the data analysis the comparator output will also return to the one state. When both inputs to one half of the dual NAND gate Z52 are ones, its output will go to a zero. When this occurs, bistable multivibrator, Z51 will be set to the inhibit mode. The pulse height analysis channel is then inhibited through the action of gate Z 43 which requires all of its inputs to be up in order to gate the clock pulses and begin height analysis. Thus we have seen that the microphone signal occurs first, or it is allowed within 100 microseconds after the occurance of either an A or B film. These signals start the beginning of readout pulse, which initiates the 100 microsecond waiting period for sampling the microphone data.

Let us now trace the initiation of film data from the sensors through the film pulse height analysis. Return to sheet one of the schematic diagram.

schematics of which are shown in Appendix A. These amplifiers have a 50 db gain and are especially designed to interface with the capacitor sensors. They are operational type amplifiers which have summing resistors at the input, so that calibration signals to this channel may be easily inserted. The three inputs to this amplifier consist of the film signals, the in-flight calibrate signals, and finally the ground support equipment signals which are used to run calibration curves on the film channels during manufacture and tests. The amplifier was designed as a three-stage inverting circuit, with two individual feedback loops used to achieve low input impedance, low output impedance, and at the same time, maintaining a large gain per stage in the individual transistors. The input stage of this amplifier contains shunt feedback with circuit parameters chosen so that the feedback resistance, or equivalent Miller effect resistance change under temperature exactly compensates the h_{fe} change with temperature, thereby enabling the gain to remain constant over the expected -55°C to +100°C temperature range. The second stage is a conventional high-impedance, input, low impedance output NPN and PNP pair, noninverting, designed to drive efficiently a long length of coaxial cable. The response time of this amplifier is less than 1/2 microsecond to the leading edge, while the trailing edge is sufficiently coupled through the stage to prevent serious under-shoot. The under-shoot of the trailing edge of the signal is important if the trailing edge is to be used to form a pulse height analysis, since this will result in a consequent over-shoot which may be detected in later stages as an additional film pulse giving erroneous data.

It is therefore by careful design that exact parameters were chosen in this amplifier so that the output is critically damped after one undershoot of the trailing edge. Also incorporated in this amplifier is a biased-diode feedback network which changes the gain of the amplifier if the signal at the output of the amplifier exceeds one volt.

This gain reduction reduces required dynamic range of the succeeding stages so that conventional power supply voltages may not be exceeded. The output of the capacitor amplifiers were both the film A and film B channels is applied by coaxial cable to the input of the digital section which is shown on sheet two of the schematic diagram.

We have seen how the mic signal analysis is performed and we have seen how the requirement has been placed on the microphone pulse height analyzer that this signal occur within 100 microseconds after the occurance of a film hit. We now take the case where the microphone signal has occured first, and we put the same restriction on the film signals-that they occur within 100 microseconds after the initiation of a Beginning of Readout pulse by the microphone.

We have seen that the microphone one shot, Z50 Pin 6 going to a one state actuated dual NAND gate Z70, the output of which was applied Z12 which when coming down initiated the beginning of readout. In parallel with the output Pin 12, Z70 are the outputs Pin 12 and 6 of Z76 which together with Z70 form an Nor circuit. Therefore either film channel which has been impacted caused the inputs to Z76 either 5 and 3, or 9 and 10, to go to a one, initiating a Beginning of Readout pulse. We see that the other output Pin 8 of Z50, the microphone one shot is applied to Pin 7 and 9 of dual NAND gate Z68 in the film section. Since this output of the one shot is negative going, the NAND gate will be activated, thereby its output going to a zero, when Pin 9 and 7 go to a one. There is also a requirement on this NAND gate that Pin 10 and 11 be at a 1 before a signal output on Pin 12 is obtained. This insures that a 100 microsecond waiting period has elapsed before an outpu can appear from this NAND. Since this output resets bistable multivibrators Z61 and Z65 to inhibit the film channel for the rest of the read out, this inhibiting is delayed from the beginning of a mic pulse by 100 microseconds, or it is delayed until film comparators are returned to their quiesent state. A zero on NAND gate

Z68 Pins 2 and 5 or 4 and 8 cause Pin 6 of the gate to go up and therefore Pin 10 and 11 of dual NAND gate to go down. When these Pins return to their upstate, the output on Pin 12 will go to zero causing a reset to occur on bistable multivibrators Z61 and Z65. NAND gates Z70 and Z68, then, reset the film channel to the inhibit state either after analysis of the film channels, or after 100 microsecond interval of the mic has occurred first.

The output of Pin 6 the dual NAND gate Z which is derived from the two comparators supplied to the film accumulator binaries Z41, Z40, Z39 and Z38. Since this happens when either comparator is actuated, the total count in the film channel is recorded. Notice that the accumulation will not be dependent on the status of the inhibits on the pulse height analyzer.

The reseting of all the storage binaries in the data chain is accomplished at the beginning of readout. This insures that all bits will be at the 0 state with the minimal probability that noise could occur to disturb the data prior to readout.

The identification of which the two bi-directional films was impacted, channel A or channel B is stored in bistable multivibrators Z36 and Z37. They are toggled at the end of analysis when the parallel NAND gate returns to its initial state. At this time one of the bistable multivibrators, Z61 or Z65 has a one and the other has a zero. These outputs are applied to the stearing inputs of the film identification binaries Z36 and Z37.

We have now seen how the film and microphone signals have traversed through their amplification stages and have been pulse height analyzed. We have seen how the events in the microphone detector and in the two film detectors have been recorded in accumulators and how film identification has been accomplished. We will now consider the ancillary circuits which are located in this part of the electronics.

The noisy film circuit, modules Z74 and Z75, and gate Z76, Z70 and Z76 generate the beginning of readout. If we were to inhibit the film channels we would necessarily do it at Z76. We require Pin 7, 4, 11 and 8 to be up before the initiation of readout can be accomplished by a film hit. This gate is controlled by trigger circuit Z75 which will be activated when the films become noisy.

Trigger circuit Z75 is a positive-feedback circuit which is initiated by an integrator Z74. The input to this integrator circuit is OR output of the comparators. The integrator time constant is such that if the data rate in the two comparators exceeds a preset level, the trigger circuit Z75 generates the required zero at Z76.

If we return to sheet one of the schematic, we may follow the signal as the calibration mode is initiated. We see that the calibration signal forms a positive going pulse which is applied to dual parallel NAND gates Z11 and Z12. The selection of which of these gates is actuated by this pulse is made by bistable multivibrator Z13 which is toggeled by this same one shot. Alternate gates will be selected with the application of calibrate pulses. The output of Z11 (Pins 6 and 12) are applied to Z18, the mic calibrate module Z12; outputs Pins 12 and 6 go to the film calibrate modules Z16 and Z17. The mic and film calibrate modules are voltage dividers which generate levels for calibrating the channels. These modules which are capable of generating two different levels, alternately sampled, form the input levels of the pulses to the mic and film channels. The duration of these calibrate pulses is determined by the duration of the one shot pulse; the leading edge is utilized in the calibration.

In addition to the mic and film amplifiers and the calibrate logic, the sensor electronics contains the heater amplifier, Z15 and is a closed loop sensing circuit using RT4 and a 1 watt heater element supplied by collector current in Q3. Thermal studies recently made on the surveyor spacecraft and the micrometeorite experiment have cast some doubt as to the need of heating. This module does not appear in the final flight configuration. To the upper right hand section of the drawing we see RT3 which is the spacecraft temperature probe, a sensistor probe through which a constant current 5 ma is maintained.

We have now seen how the acoustical sensor signals as well as the capacitor signals have been amplified, detected and analyzed in the pulse height analyzers, and how the totalizing of this flux has been recorded in accumulators, and the job. of the peripherial circuits such as the noisy film trigger circuits. The calibration circuits have been utilized in the sensor electronics and the upper section of the inboard electronics. We have seen that the occurance of a particle impact, which triggers the microphone channel or the film channels, begins the readout by causing a negative pulse to appear on the Beginning of Readout line. A signal on this line establishes a new state in bistable multivibrators Z20 which enables NAND gate Z19 to allow the sequencer, modules 1 through 5, to begin counting. The sequencer is coded into the data NAND gates Z2 through Z11. The counts of 1, 2 and 3 in the sequencer chain transmit a 001 at the output of the experiment. With the occurance of a 4, the first data bit is transmitted and so on. A one is transmitted when the clock pulse originating at Z24 is allowed to strobe the coding gates. The particular gate which will be sampled is determined by the status of the sequencer flip flops. The coding of the gates is binary/decimal which allows the gates to be sampled in the order of their intended readout. The data to be read out consists of mic pulse-height analysis, 3 bits, mic accumulation, 3 bits, film pulse height analysis 4 bits, film accumulation, 4 bits, film identification, 2 bits.

We are to return to the enabling of gate Z19 through the action of output of Z20 becoming a one, we see that the 4, 5 and 8 leads at that gate are brought to a 1, and if we examine the remaining input, Pin 3, we see that it comes from the 100 microsecond one shot which is actuated on the trailing edge of the clock strobe pulse, therefore, the toggeling of the sequencer by this NAND gate of which the output is Pin 6, will occur on the trailing edge of the strobe pulse. Data is sampled and the sequencer toggeled when bistable multivibrators Z20 output is Q in the one state, which indicates that new data is ready. Half of the gate, Z19, part of a logic network which is associated with half of Z17, the output being Pin 12, constitutes the microphone accumulator inhibit. These two gates sense when the microphone accumulator is being sampled; and prevents any further accumulation during this particular interval of the readout. Data is accepted in the accumulators except when the data is being sampled, this accumulator inhibit is applied to NAND gate Z52, in the upper housing, to inhibit the microphone accumulator.

Now if we return to gate Z18, we see that the output Pin 6 of that gate supplies a pulse which resets the readout binary Z20. Pin 6, 3, 4, 5 and 8 of Z18 form a detect 20 circuit which detects the end of readout and supplies a reset pulse to multivibrator A20. Now if we examine the Pin 12 output of Z18, we see that the input associated with this output are 7, 9, 10 and 11. Pin 7 comes from $\bar{Q}$ of the enabling flip flop Z20 which will normally be up when the flip flop is in its quiscent condition, therefore, with no readout occuring, this gate is enabled and is strobe by the same one shot that occurs on the trailing end of the clock pulse at Z21. The output of this gate is constantly activated when no data is present and as we see this output is used to reset the bistable multivibrators continuously so that no noise can enter and distrub the status of these bits, so that we are always assured of having a reset condition in the binaries at the beginning of the readout.

GROUND SUPPORT EQUIPMENT

The ground support equipment for the Surveyor Ejecta Detector is a portable test set which supplies the ejector detector experiment with DC power, simulated impact stimuli, telemetry commands, and provides the experiment with a visual readout display.

The unit is housed in aluminum case which is extremely rugged and may easily be transported to various test locations. The readout of the data is in numeric form which can be easily correlated with input selection. The input selection is made by the use of array of lighted push button switches in conjunction with precision vernier potentiometers. The unit may be powered from a conventional 117 volt AC 60 cps, source or battery power may be used. If nixie readout is desired during battery operation, this portion of the GSE may still be AC powered. Otherwise an oscilloscope readout must be used.

The GSE is shown with the Ejecta Detector in Figure 4. The electrical schematic is shown in Figure 5. The system is divided schematically into four groups; they are: Sheet 1, Digital Readout and Commands; Sheet 2, Switch and Meter Circuits; Sheet 3, Sensor Stimulus; and Sheet 4, Power Converter.

The Digital Readout and Command section of the system contains the circuits necessary for storing the 19 bit readout word and driving the nixie displays, and also contains those circuits necessary to generate the telemetry commands.

We shall assume that the experiment has received a hit and begins to transmit a 001 code word. We shall follow the sequence of events which leads to a readout display. On the left hand side of the schematic (Sheet 1) we see the data input and the experiment clock

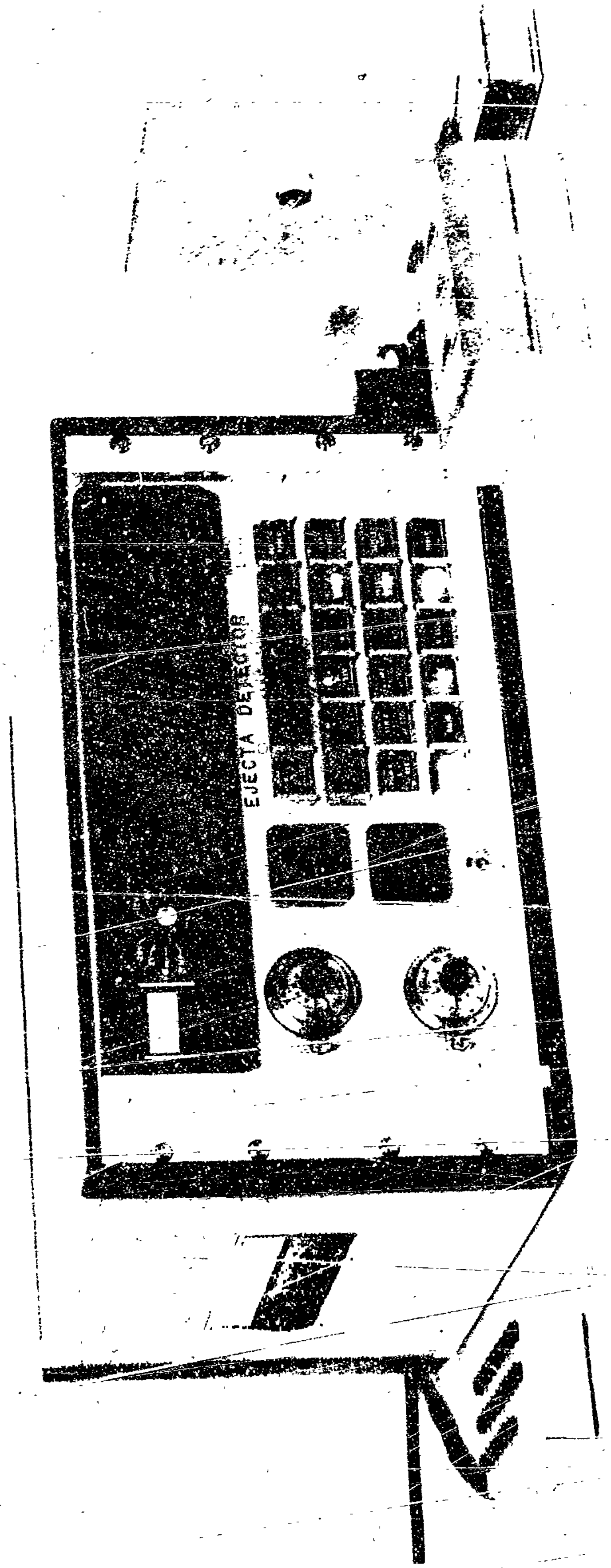


Figure 4. Ejecta Detector Experiment and Ground Support Equipment

brought into the GSE. Remember in the write up of the system that the data at the output of the experiment changes on the positive leading edge of the clock pulse, so that if we were to have a one of data it would occur at the time of the positive clock pulse. The clock is applied through an inverter Z9 to one shot Z10 so that on the positive edge of the clock the one shot will be triggered. The output Z10 is a positive-going signal applied to Z11. Z11, a one shot, will trigger on the trailing edge of Z10 after a three millisecond delay. We now have generated a 200 microsecond pulse at the output of Z11 which is positive-going and occurs on the leading edge of the clock pulse from the experiment. This positive going pulse is applied to gate Z12 and to the toggle inputs of shift register Z3, Z4 and Z5. This shift register is driven from the data line which consists of the incoming data and the Z6 inverted output Pin 6. The delayed negative transition occurring at Pin 6, Z11 acts as the toggling or sampling pulse for the three-bit shift register, Z3, Z4, Z5. It samples the incoming data which is continuously applied to this register. We see that gate Z1 is coded to be conditioned when a 001 exists in the shift register; therefore, its output will come down at the time of the trailing edge of the 200 microsecond pulse at Z11. That is, the time when the shift register has just changed to the new status-001. At this time bistable multivibrator Z2 is set, so that the output, Pin 5, goes to a one. This output lead is the other input to gate Z12 which is also driven from the 200 microsecond pulse. Since that pulse had just terminated by the time the bistable multivibrators Z2 had assumed a one status, Z12 gate will not be enabled until the next positive going edge of the experiment clock pulse occurs, and 3 ms later this gate will be conditioned to cause a negative transition of the input to driver Z13. This driver will generate the toggling or sampling pulse on the main shift register Z8, Z20, Z21 through Z34. Therefore, we see that the sampling of the principle shift register Z8, Z20 through Z24 does not occur until after the code address 001 has been registered in the ancillary shift register Z3 through Z5; at this time, the system will wait for the next positive clock pulse from the experiment, and 3 milliseconds later, will generate the sampling pulse for the main shift register. The sampling pulse will occur approximately in the middle of the positive-going half of the clock when a one should be present in the RZ experiment data.

This principal register will continue to be sampled and will continue to shift as long as gate Z12 remains conditioned by bistable multivibrator Z2. This multivibrator will stay in the one state until its reset line, Pin 8, is pulsed. This reset line is driven by one shot, Z7 which is, in turn driven by the AC driver, Z19. The AC driver, Z19, will receive a pulse when a count down chain, Z14, Z15, Z16 and Z17 has reached a full recycle count of 16. This occurs when the Q output of bistable multivibrator Z17 returns to a zero. A negative pulse will be generated at capacitor Z33 and diode CR2, and be applied to input of driver Z19 on Pin 7. When 16 clock pulses have sampled the main shift register, bistable multivibrator Z2 will be reset after a 400 microsecond delay which is generated by one shot Z7. The AC driver, Z19 resets the count down chain. One shot Z7 will reset the auxilliary register. If a 001 had appeared in the data, gate Z1 would be again enabled; however, since bistable multivibrator, Z2 has been previously set, the enabling of gate Z1 is ignored during the readout and this condition does not disturb the operation.

At the end of readout, the shift register will store the data until new data is received. Until a new code recognition occurs, this data is displayed by nixies, binary-to-decimal conversion assemblies DS1, DS2, DS3, DS4, DS5 and DS6. These are assemblies accept, the 3 v logic levels convert to decimal form. The ancillary register Z3, Z4, Z5, at the conclusion of a readout is reset to ones.

Had the register been reset to zeroes, upon receipt of the first one of the quiescent transmission of the experiment, (which transmits a continuous stream of ones) erroneous code recognition would have taken place. We eliminate this problem by storing all ones in the register prior to receipt of the continuous data transmission of all ones.

The count-down chain and ancillary register is reset by driver Z19 at the conclusion of a readout cycle. This driver is triggered by the count of 16 being reached in count-down chain, but it may be also triggered by two other signals, the Sensor Actuate signal and the Command Actuate signal. These signals are applied to the driver through C13 and C12. Immediately before putting data into the sensor channels, the circuits in the readout portion are reset so that, had noise triggered a flip flop to the wrong state, the resetting would occur, and make this flip flop go to its proper state. The input through C12 comes from a one shot, Z38 at the application of a push-button switch which initiates the commands. Before a command is inserted into the experiment, the flip flop in this section of the GSE are reset.

The commands are generated in Parallel AND gates Z35, Z36, and Z39, in conjunction with voltage dividers R2, R1, R3, R4, R5 and R6. These AND circuits are noninverting gates having PNP outputs. The inputs to these gates are a strobe one shot Z37 and levels from enabling selection switches on the front panel. The strobe one shot, Z37 is actuated by one shot Z38 which in turn is triggered by the actuation of the Enter Command switch on the front panel. The command is first selected by depressing the selection switch and the command is entered by pressing the momentary push button switch which sends a pulse through resistors R7 and R7A at the input of one shot Z38. This one shot, in turn, triggers one shot Z37, which strobes the gate selected to give the command. The command pulse width is 20 milliseconds conforming with the spacecraft telemetry specification and simulates those commands that would actually occur in the spacecraft.

The circuits in the lower right hand corner of the schematic are those which generate either continuous data impacts or utimately enable the insertion of data by push button switch. If continuous data is desired, that is, if continuous hits are to be inserted, Z44, clock module, produces pulses which strobe 1/2 of dual NAND gate Z43. Now this half of the NAND gate is selected when the Manual / Repeat selection switch is in the Repeat position, putting a one into inputs 5 and 8. The output of this section of the gate is Pin 6, and Pin 6 toggles bistable multivibrator Z42, and triggers one shot Z40, which pulses the Sensor Actuate line. This line eventually produces all of the sensor analog signals. Pin 6 of Z42 is also applied to Pin 9 of Z41 which produces the Enable Stimulus signal which occurs prior to the Sensor Actuate signal. The relation between these two signals will be explained as we explore the sensor signal generation.

The other half of Z43 is used to set the bistable multivibrators and begin a data readout. This setting will occur when the repeat manual switch is in the manual position and when the Enter / Data push-button is depressed. When lines 10, 7, 9 and 11 are at ones, the output, Pin 12, will go to a zero. Z43 will be reset when the push-button is returned to its normal position since Pin 8 will be grounded as the push-button returns to its quiescent condition.

In this discussion we have seen how data from the experiment is stored in the GSE and section how the 001 code recognition takes place, and we have seen how the commands are generated, and how Sensor Actuate signal is produced, either by continuous clock or by depression of the Enter Data push-button switch. We will now go to Sheet 2 of the schematic, the Sensor Stimulus section and see how the actual analog calibration pulses are generated upon receipt of a Sensor Actuate Signal.

The Sensor Actuate signal is applied to module Z45; the output module Z45 is applied to Z46. The output of Z46 is applied to Z47 and Z47 to Z48. Each of these modules contributes a delay which corresponds to the numbers in microseconds of the delays of the second through the fourth columns of selector switches on the front panel: 50 microseconds, 500 microseconds, and 50 milliseconds. One shots Z49, Z50 and Z51 are triggered on the leading edge of the outputs of the first three modules so that the first one shot pulse occurs immediately upon receipt of the Sensor Actuate signal. The second occurs after a 50 microsecond delay and the third occurs after a 500 microsecond delay. The output of these one shots are positive going pulses which strobe AND/ORcircuit Z53, Z54, Z55 and Z56. The output of the last one shot in the one shot chain Z48, strobes gate Z57 and part of Z56.

These gates generate pulses which are applied to NOR gates Z59, Z62 and Z63 which generate the strobe waveform for the microphone, Film A and the Film B channels. The strobe pulses from these one shots are applied to parallel AND gates Z64, Z67, Z69, Z72 and Z74. These parallel AND gates are used to drive the cable driver modules Z65, Z68, Z70, Z73 and Z75. The DC voltage supply for these driver modules is selected to be the analog level of the pulse that is desired. The output stage of the driver module is simply a saturating transistor switch which saturates from the B+ supply that is generated by the analog selection level as determined by the switch settings on the front panel.

Arranged sequence at which pulses are generated in each of these channels is so as to insert signals throughout the duration of a readout. Signals are inserted, in addition to the beginning of readout, during the times that inhibit functions should be occurring in the system such as the microphone accumulator inhibit, the microphone PHA inhibit, the film PHA inhibit, and film accumulator inhibits. To check out all of these inhibit functions, some signals are injected automatically whenever a readout occurs and some signals are selected from the push-button array on the front panel.

Pulses may be selected in any of the three channels at intervals of 50 microseconds, 500 microseconds, 50 milliseconds and 150 milliseconds. The 150 millisecond timing is accurately made by taking a signal off the countdown chain which is counting down during the readout and using this signal to generate the 150 millisecond strobe. A sequence of hits and the relative timing between them is shown in Appendix C.

The logic provided by modules Z52, Z53, Z54, Z55, Z56, Z57, Z59, Z60 and Z61 is simply and AND arrangement whereby the strobe pulse occurring from one of the one shot modules Z49 and Z50 or Z51 is required to have coincidence with a one which occurs from any of the inputs from the delay time selector switches on the front panels. If this coincidence occurs, the signals are inserted; the output of these AND circuits drives a transistor NOR circuit so that various pulses which have been selected may be taken in sequence through a common output gate to the desired channel; these NOR circuits are Z59, Z60 and Z61. They form the summation point at which the pulses at the various time intervals are summed onto the one line of each channel.

Since it is desired to interlock the system to the extent that we do not want to insert rapid hits during pulse height analysis, the outputs of one shots Z58, Z62 and Z63 are fed back to certain AND gates as inhibit functions, so that once these channels are excited during PHA interval, no other excitations can occur in that particular interval. These one shots are chosen with widths which correspond to the PHA interval. The lights on the front panel are coded to indicate hits which have been selected will not get through to excite the system. If we press the zero microsecond on the mic we cannot light the 50 microsecond button because this 50 microsecond signal will occur during the first 100 microsecond of the microphone PHA and this is not allowed.

The DC levels supplied to the driver circuits of Z65, Z68, Z70, Z73 and Z75 are established by either the vernier controls R63 and R73 or the preselect thumb wheel switches consisting of S26 and S27 and resistors R63 through R91. The selection is determined by the position of the Preset/Vernier switch on the front panel. If this switch is in the Preset condition, the DC level for the driver circuit is taken from the junction of R72 and the wiper arm of S26. If the switch is in the Vernier position, the DC voltage for the mic circuit is taken from the Mic vernier potentiometer arm. In similar fashion, for the film circuit, if the switch is in the preset position, the levels for the film drivers is taken from the junction of R96 and wiper arm of S27; if it is in the vernier position, the levels are taken from the wiper arm of R73. The mic preset switch S26 consists of a 8 position divider, the levels of which are adjusted to give those appropriate window 0 through 7 on the mic pulse height analyzer. In the film channel, the range is divided up into two sections, 0 through 9 and 10 through 15. If windows 0 through 9 are desired, the right most thumb wheel switch, S28A, is placed in the 0 position, and resistors R82 through R91 form part of the voltage divider network. If switch S28A is in the one position, we are considering levels 10 through 16 and the appropriate levels for those windows will be generated by the resistor divider network R96 and R75 through R81.

The film channel, unlike the mic channel, having a very wide dynamic range, necessitates the division of the signals into two different ranges: a high range and a low range. This division enables the signal levels on the coaxial line to be within the range where noise can be rejected easily and the signals can be easily handled. These lines have approximately the same voltage levels on them but at the experiment end of the GSE/experiment cable, an attenuator (See Appendix) is placed in the line so that the whole dynamic range is transmitted with a minimal noise interference. The selection of which of these lines the film signal is to be transmitted on either high or low, is made in switch section S28B if the analog signal is being generated by the film vernier control. S29A is a toggle switch which is used only when the film vernier potentiometer is being used. Its position in relation with the preset controls is not important.

The outputs of driver modules Z65, Z68, Z70, Z73 and Z75 appear on coaxial lines from P6. The returns of these signals are brought through seperate leads and are isolated from DC ground by inductors L7, L8, L9, L10 and L11. These inductors constrain the return currents to their appropriate shields, so that a common coupling problem does not exist on the mutual DC return between the GSE and the experiment. Across the variable B+ selected by the vernier or preset controls are capacitors C27, C28 and C29, which supply the current demands of the rapidly saturating transistor switches which form the output pulses to the experiment.

We notice in our observation of Sheet 1, that the Sensor Stimulus Enable signal came to a one prior to the Sensor Actuate signal. This level is applied to parallel AND gate modules Z64, Z67, Z69, Z72 and Z74. This DC level is down except when a Sensor Stimulus is desired, and reduce the probability of an extraneous signal appearing on one of the data output lines, and is added as a special precaution in this GSE. We require the coincidence of the Sensor Stimulus signal as well as the Sensor Stimulus Enable before an output pulse is generated. The probability of both occurring at the same time reduces the probability noise is greatly probability without the coincedence.

Let us now examine the operation of the circuits on Sheet 2 of the schematic, the Switch and Meter Circuits. We see the selector switches are four pole double throw switches being utilized. The data interval selection at which the microphone Film A and B channel pulses are inserted is in the upper left hand portion of the switch array. The Heat switch turns the heater power on. The Repeat Manual switch determines whether hits will be inserted by Push Button with the Enter Data switch or started by a continuous clock which runs at a second rate. The Preset Vernier switch was explained previously. The Battery/AC line switch controls where the suitcase derives its primary power from, that is, from a greater than 12 volt battery or from the 117 AC line. The Power switch turns the power to the GSE on and off. The three command switches, Calibrate Command, Clear Command and Read Command are generated by depressing one of these switches, S20, S21 or S22, and then by an Enter Command momentary contact switch S23. In a similar manner, data is injected by preselecting one of the time sequence switches in the upper left hand portion of the array and depressing the Enter Data switch.

All of the switches on the front panel are alternate action type, this meaning that they will stay in either of the alternate positions once depressed except S19 and S23 which are the initiating switches for entering data or commands.

The metering circuit is shown in the upper portion of the schematic, as is the constant current generator Q1 and Q2. This constant current generator is used to excite the sensistor temperature probe which is located in the sensor unit in the experiment. The current generator consists of driving transistor Q2 and output transistor Q1. The constant current is derived from the collector current generator internal to transistor Q1. The current to transistor Q1 is established by an accurate voltage reference across its emitter resistors R13 and R14. This current is established through the emitter follower action of Q1 and Q2. The reference voltage is derived from CR2A, precision reference diode. The current from Q1 flows through the temperature sensor probe in the experiment. Voltage across Q1 to ground, is measured as the output voltage of the sensor as applied to the input position No. 1 of selector switch S25A.

This switch determines which of the circuits is to be metered by microamp meter M1, which serves as a null-detecting meter. The reference for null-detection consist of the voltage derived from precision voltage divider to the right hand portion of the schematic, beginning with R18 and ending with R56. The 100 ohm resistors in this divider are inserted to account for tolerance buildup in the resistor chain as well as for slight unbalances which may occur in the matched pair emitter follower Q3A and Q3B. The emitter resistance of the emitter followers in this case is replaced by constant current generators Q4 and Q5, maintaining the current through these matched emitter follower constant regardless of the level changes at the basis of the emitter follower. High current ratings and unbalances do to wide variations in emitter current are avoided. The current reference is established by CR7 on the basis of Q4 and Q5. The sensitivity of the meter is adjusted by the use of fixed resistors R21, R23, R25, R27, R29, R31, R28 and R25 in conjunction to variable potentiometers R20, R22, R24, R26, R28, R30, R32, R34, which are placed in series with the meter. These additional resistance variations allow for variations and transistor parameters as well as slight design tolerances.

The levels established for this potentiometer circuit when measuring the +3, +12, +6 and -7 volts are nominal. In the case of the temperature probe, the voltage of the bridge is 2 1/2 volts, and in the case of the 29 volt supply, this voltage is divided so as to reduce the dynamic range required on the metering circuit. Diode CR5 and CR6 are silicon diodes which are used to protect the meter; that is, if the drop across R19 and the meter exceed diode conduction voltage the diode will carry the bulk of the current thereby protecting the meter from transient overloads. The meter circuit is designed to measure the tempe ature of the unit in °C. The primary current appears directly in milliamps. The meter circuit is a direct reading 0 to 50 milliamp movement with no null detection. Meter point which is nominally 2.04 volts as an null detector, measures 28 volt primary supply. Calibration curves for the temperature sensor in unit 1 is included in the test results section along with the meter readings observed on the first unit.

Refer now to Sheet 4, the Power Converter section of GSE. This portion of GSE takes the 110 volt AC power and converts it to +29 volts for the experiment excitation and generates +3 volts for the logic circuitry as well as +30 volts for the meter circuits. It also generates the heater 22 volt. The 110 volt power is applied through an AC line noise suppression filter SP 30278, which is π network filter and is applied to the power switch S24 which is an on-off switch. The power is supplied to the transformer T101 which converts to 6.3 volts for the lamps, and to PS1, the 180 volt high voltage power converter, and finally is applied to transformer T102 and fullwave rectifier CR101 and CR102, CR103 and CR104, filter L104 L106, C105 and C107. The output of this filter is a DC voltage of approximately 12 volts which is applied to the input regulator Q101. Q101 is driven by differential feedback regulator module Z101 which maintains the voltage output at the emitter of Q101 at exactly 11 volts. This 11 volt is applied to a DC inverter Z102 which oscillates at a frequency of 2500 cycles per second. The oscillator transformer is T103 and the voltage converter transformer is T104. The secondary to T104 contains the rectifier doubler windings 4, 5, 6, 7, 8 and 9 for the 30 volt regulator, the synchronous rectifier windings 10, 11, 12, 13 and 14 for synchronous 3v rectifier, and the regulator doubler windings for 15, 16 and 17 for the +29 volt regulator supply.

The outputs of these windings are applied respectively to rectifier doubler Z105 and 30 volt feedback regulator Z104. The 30 volt is filtered by capacitor C112 and appears at connector J8. The heater regulator is designed to always draw a constant current fromthe secondary of transformer T104 thereby maintaining a constant load of an input regulator Z101. This insures that the other voltages in the circuit and the Z101 regulator as well as the critical inductances of L104 and L105 need not be large. The constant current in this regulator is taken from transistor Q103 or is dissipated in transistor Q105 if no load is being drawn by the heater. This occurs through a feedback network consisting of the 36 oh m resistor and series with the emitter of Q105 and the regulation transistor Q104. The voltage at which the heater operates can be adjusted from 16 volts to 28 volts. The synchronous rectifier is a conventional one, the output voltage of which is filtered by C113. The rectifier-doubler Z105 and Z106 supply the 29 volts. Z106 is a feedback differential regulator, the output voltage is adjusted by resistor R110, and output current is sampled at R109, this is applied to the metering circuit which measures this voltage, thereby determining the current which is being demanded by the experiment.

If a battery operation is desired, the battery is applied to terminals J10 and J11. The battery should be in excess of 12 volts to allow for battery deterioration. The fuse F101 diode CR105 will protect the circuits in the event the battery is connected in reverse. If the battery potentials are applied in reverse, diode CR105 will conduct heavily, causing fuse F101 to blow immediately, thereby protecting the transistor circuits. The output voltages appear at the power converter board connector J8 and are transmitted on separate lines to the various circuit groups so as to minimize mutual coupling throughout the GSE. A complete operation manual of the GSE in included in Appendix C.

TESTS AND TEST RESULTS

The first unit delivered was the thermal study unit which contained only resistors to simulate the power dissipated in each section of the electronics. Test data for Serial Numbers 2, 3 and 4 are included in this section. Serial Number 2, was the first working prototype which was to operate at room temperature only. The unit test results are shown in Figures 6 and 7. These data represent the input voltages applied to the microphone and film channels and represent the overall transfer function of the system from analog input to digital output. After this system was designed and delivered, the sensor electronics was modified to account for new test data on the films which were being supplied by the Goddard Space Flight Center. The new electronics contained a highly sensitive film amplifier which was installed in Serial Numbers 3 and 4. The data for serial numbers 3 and 4 are shown in Figures 8a, 8b, 9a, 9b, 10a and 10b. These data include temperature runs which to simulate the temperature variations will be experienced by the two different assemblies on the moon. Two ovens were used, one which contained the sensor electronics assembly, and the other which contained the power converter and digital blivit assemblies. The sensor electronics assembly was run from -50°C to 100°C, while, at the same time, the inboard electronics was run from -20°C to +55°C. Therefore, the headings at the top of the columns in the tables are so noted.

The test results for serial number 4, which is the latest unit that was shipped are plotted graphically in Figures 8b, 9b, 10b. Figure 8a, b is the data for the microphone channel and includes the calibration crystal which is mounted diametrically opposite to the microphone sensor crystal on the sensor plate; it includes the transfer function through this crystal, the microphone amplifier, PHA, and digital processing. The variation from the two temperature extremes

MIC DETECTOR INPUT(mv)	
	SN/1 +25°C
PHA	
1	110
2	180
3	273
4	400
5	660
6	1230
7	2500

Figure 6. MIC PULSE HEIGHT ANALYSIS DATA, SN1 (Driving into Mic Amp)

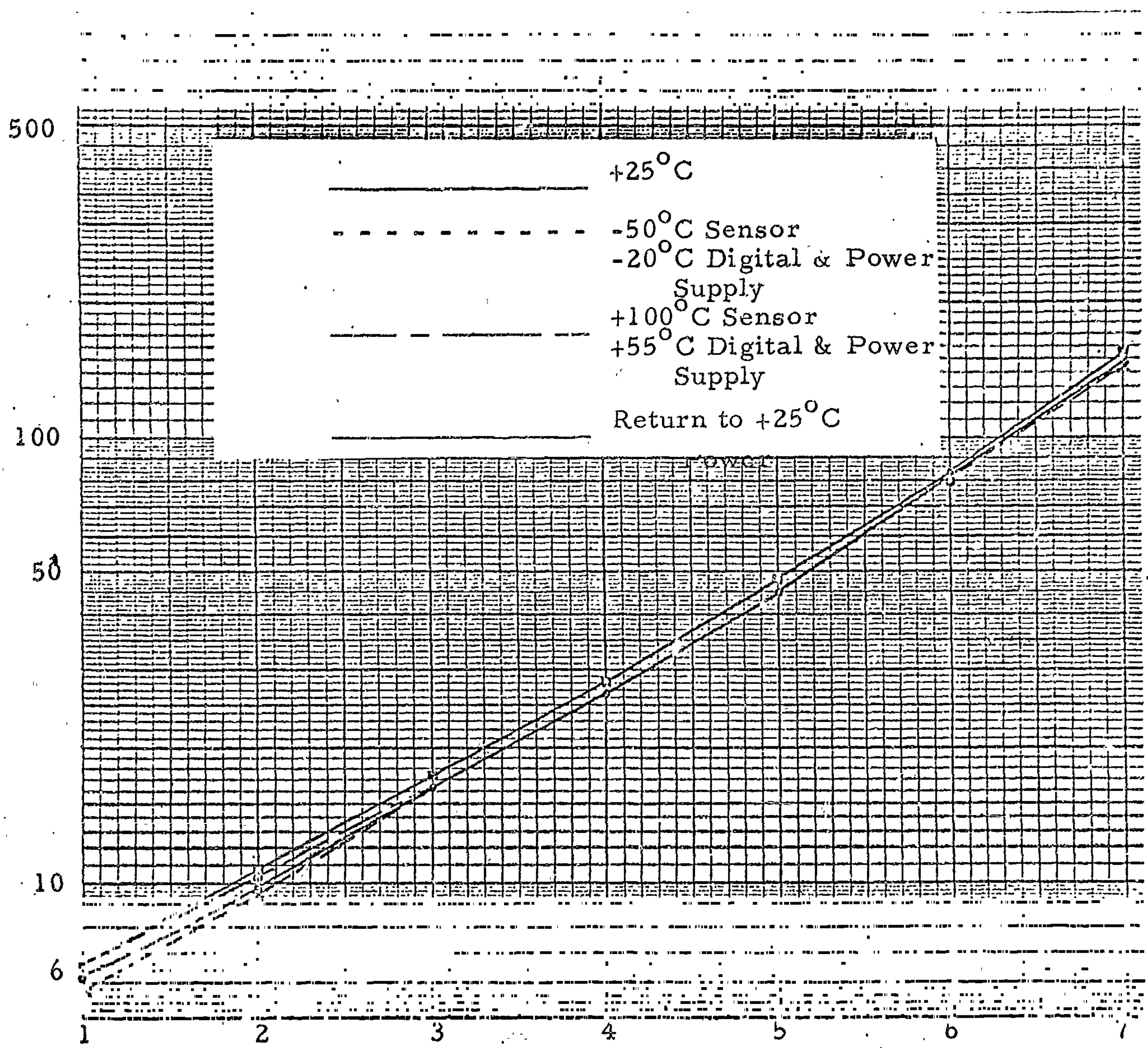
FILM AMPLIFIER CALIBRATE INPUT (mv)		
	SN/1	+25°C
PHA	A	B
1	11	11
2	13	14
3	21	20
4	30	32
5	44	45
6	67	68
7	100	100
8	149	150
9	220	219
10	340	320
11	470	460
12	710	690
13	1030	1000
14	2950	2650
15	5400	6800

Figure 7. FILM PULSE HEIGHT ANALYSIS DATA
SN 1

CALIBRATE CRYSTAL INPUT (millivolts)							
	SN/3			SN/4			
	+25°C	-50°C -20°C	+100°C +55°C	+25°C	-50°C -20°C	+100°C +55°C	+25°C
1	5.93	5.86	6.76	6.20	5.76	6.52	6.44
2	9.11	9.14	10.5	9.82	9.50	10.3	10.9
3	14.8	14.9	17.0	16.4	16.0	16.2	17.4
4	25.1	25.6	28.6	26.5	27.0	26.6	28.6
5	42.6	45.0	48.3	44.9	45.7	45.0	48.3
6	74.0	77.6	83.7	84.0	81.8	79.4	85.4
7	134	*	*	147	143	149	157

Figure 8a. PULSE HEIGHT ANALYSIS DATA, MICROPHONE, SN 3 & 4

*Step 7, on SN3 exceeded GSE Range capability. This anomaly was connected on SN4.



PHA Step

Figure 8b. MICROPHONE CHANNEL CALIBRATION GRAPH, SN 4

FILM A AMPLIFIER INPUT (nano-amps)

	SN/3			SN/4		
PHA	+25°C	-50°C -20°C	+100°C +55°C	+25°C	-50°C -20°C	+100°C +55°C
1	81.3	74.7	91.6	59.5	58.1	62.2
2	105	96.1	111	80.8	80.8	84.6
3	135	131	142	110	111	114
4	180	175	189	152	153	155
5	240	238	249	207	211	209
6	326	324	338	285	289	287
7	444	444	460	394	403	396
8	608	610	626	546	557	545
9	844	860	864	756	776	750
10	1170	1200	1190	1050	1080	1040
11	1630	1670	1640	1460	1490	1440
12	2440	2500	2440	2160	2290	2190
13	5600	3440	9140	3000	3150	3940
14	19800	13200	23300	12900	8140	15800
15	39800	34500	43300	30700	28200	32700

Figure 9a. PULSE HEIGHT ANALYSIS DATA, FILM A

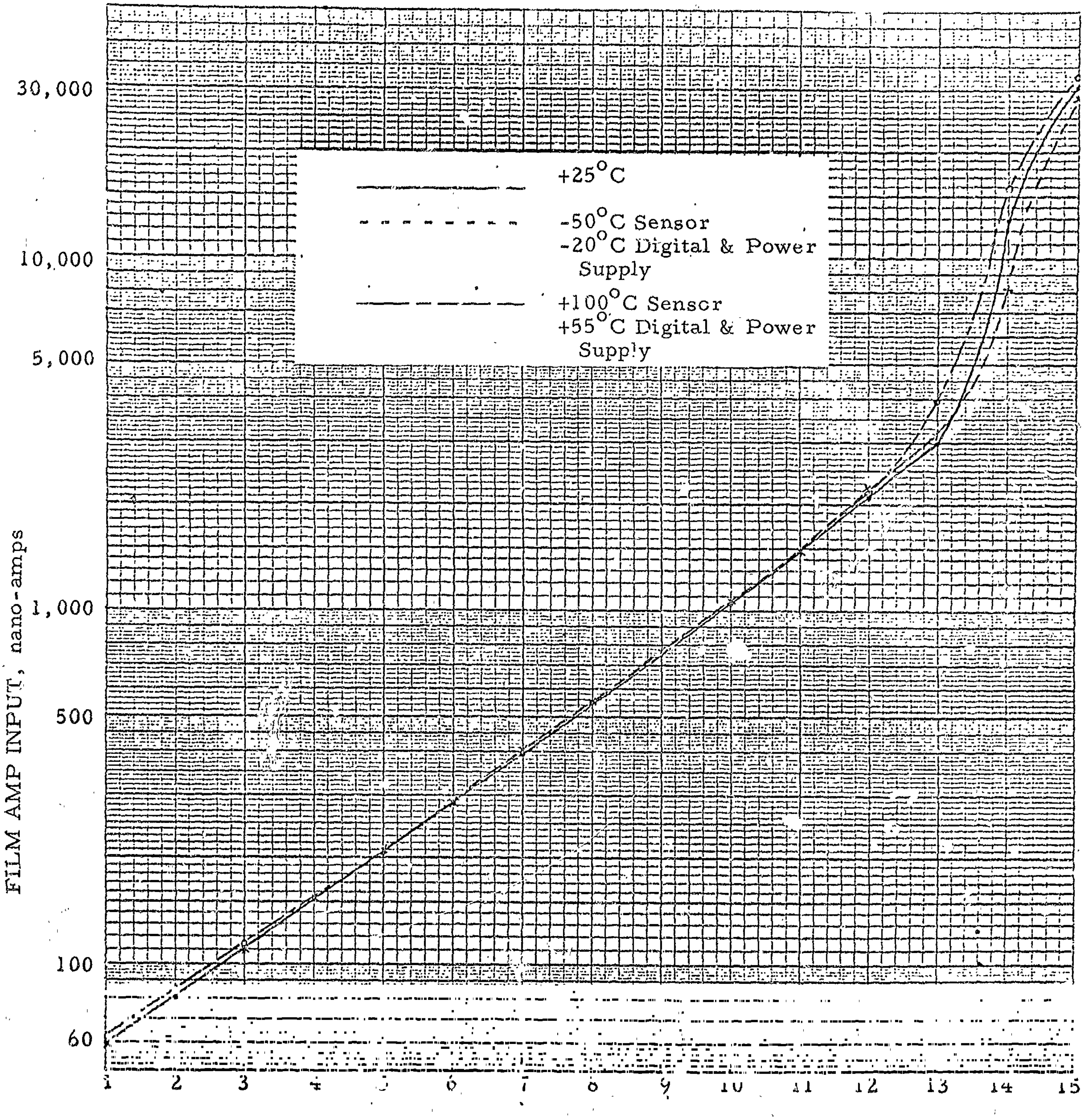


Figure 9b. FILM A CHANNEL CALIBRATION GRAPH, SN 4

FILM B AMPLIFIER INPUT (nano-amps)

	SN/3			SN/4		
PHA	+25°C	-50°C -20°C	+100°C +55°C	+25°C	-50°C -20°C	+100°C +55°C
1	77.5	68.5	80.3	59.8	57.2	62.1
2	97.0	88.5	102	77.5	74.4	80.9
3	130	119	133	106	102	109
4	177	162	183	146	141	149
5	236	218	246	202	196	207
6	321	299	330	278	271	284
7	440	410	448	384	378	392
8	604	560	613	534	531	543
9	833	787	840	740	745	747
10	1150	1090	1160	1030	1050	1040
11	1590	1510	1610	1440	1470	1440
12	2360	2250	2380	2110	2150	2090
13	5610	3110	8010	3350	2990	4320
14	19250	13100	21600	15900	12900	16900
15	38200	32100	40000	34500	33000	35000

Figure 10a. PULSE HEIGHT ANALYSIS DATA, FILM B

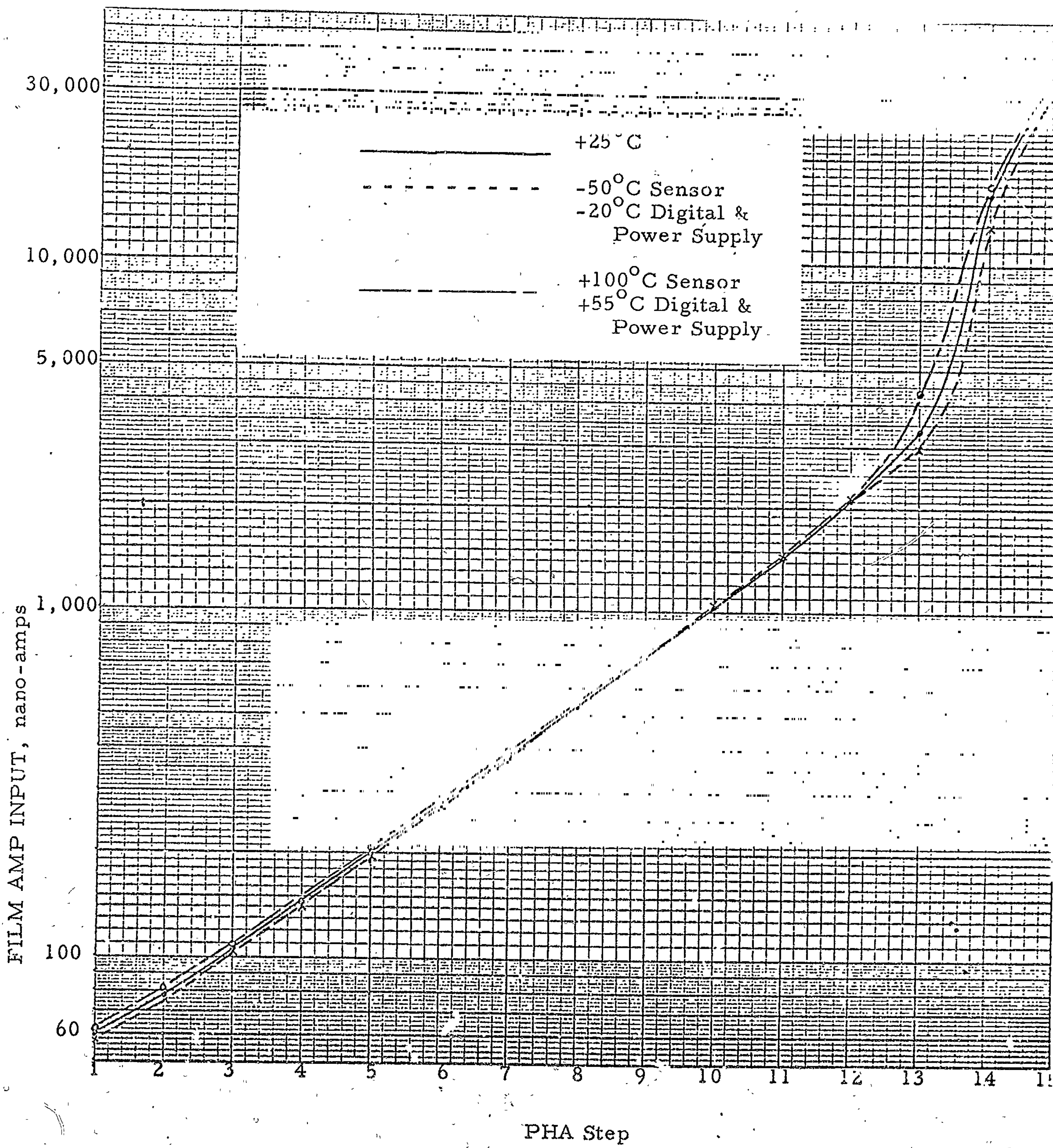


Figure 10b. FILM B CHANNEL CALIBRATION GRAPH, SN 4

is noted at the lowest levels and is well within the expected noise of the calibrate crystal input and is within a millivolt of input signal. The data stability improves as the signal level increases. It may be noted that since the gain of the microphone amplifier channel is approximately 0.3×10^4 from the microphone sensor to the gain of 2 amplifiers and is therefore, approximately $.6 \times 10^4$ to the comparator, we see with the threshold of the microphone comparator is approximately 250 millivolts, which when divided by $.6 \times 10^4$ is 40. Six millivolts at the calibrate crystal. At threshold, is equal to an impact occurring on the plate causing a 40 to 50 microvolt signal at the input of the microphone channel. The lowest levels in the test data correspond to these small signals at the input to the microphone amplifier channel through the two crystals. Figures 9a and 10a give the test data for the Serial Numbers 3 and 4, Film amplifiers and digital conversion logic. Here, the data could have been represented in equivalent nanovolts since the input impedance of the film amplifier is known (3K). The dynamic range from the first to the 15th step is approximately 500 to 1, and the stability of the numbers is quite good over the wide extreme of temperature. The results are plotted graphically in Figures 9b and 10b for serial number 4. We see the nonlinear region of the channel in the upper right hand corner including the 12th through the 15th steps. A gain change is inserted in the linear amplifier by a simple diode/capacitor network. The excursions here are those due to the diode temperature coiefficient which have been only partially compensated. The gain of the amplifier in this region has been reduced drastically, so that a large dynamic range may be achieved on the high steps while maintaining a high resolution on the lower levels. The drift of the amplifier channel under temperature on the majority of the linear range is almost negligible. The 81 nanoamp threshold is a very realistic threshold for capacitor sensors. The physical size of the system being small, these data represent a significicient advance in the state of the art in amplifiers, detection, and digital conversion.

The transfer function from GSE to sensor input for these temperature runs are shown in Figure 11.
The data in these graphs, enable the correlation of GSE test data in volts to actual sensor equivalent μv or na.

Figure 12 gives the nominal calibration of the sensistor temperature probe which is mounted in the sensor electronics unit and is excited by a 5 milliampere current, the voltages and resistances listed in this curve are those obtained from the manufacturer. An actual run using visual interpretation of the meter circuit in the GSE is also shown in Figure 12. Notice the close correlation with the manufacturers' data to that temperature, reading which is actually observed on the front panel.

MECHANICAL DESIGN AND TEST RESULTS

The logic unit of the Surveyor Ejecta Detector was designed with the concept of obtaining a structurally sound package with weight kept to a minimum. The logic unit is located on the spacecraft in a cantilevered position necessitating good structural strength with the package.

In order to meet the structural requirements the two housings were fabricated from solid blocks of magnesium giving each housing a homogeneous structure with excellant rigioity. The magnesium material, type AZ31B magnesium tooling plate, was used because of its good vibration dampening characteristics and high strength to weight ratio. Fabricating the housings out of solid blocks also simplified the design of a build-in wire well, a small channel shaped groove around the outside perimeter for inserting R-f gasketing for minimizing electrical interferences.

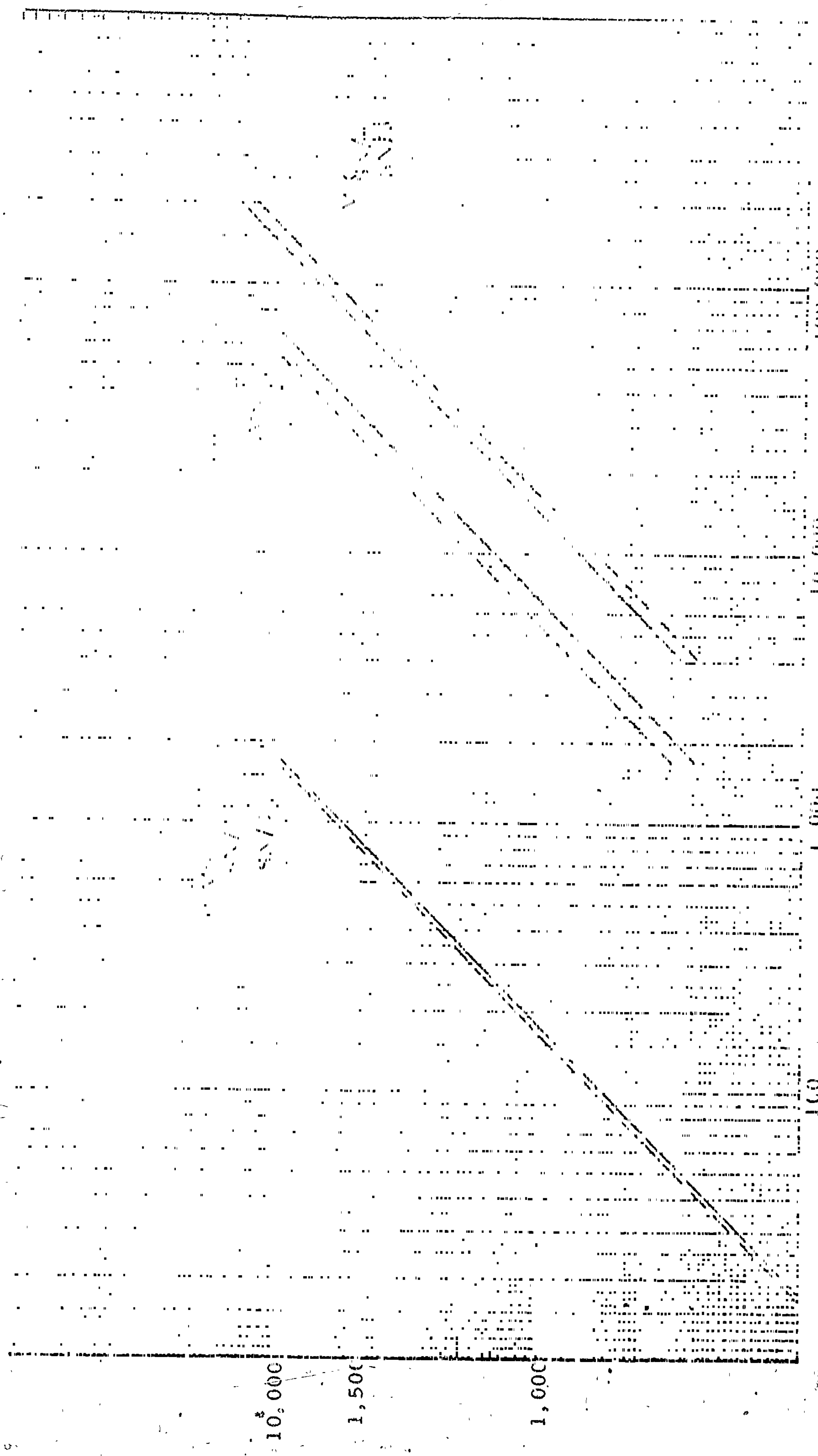


Figure 11. Overall Transfer Functions

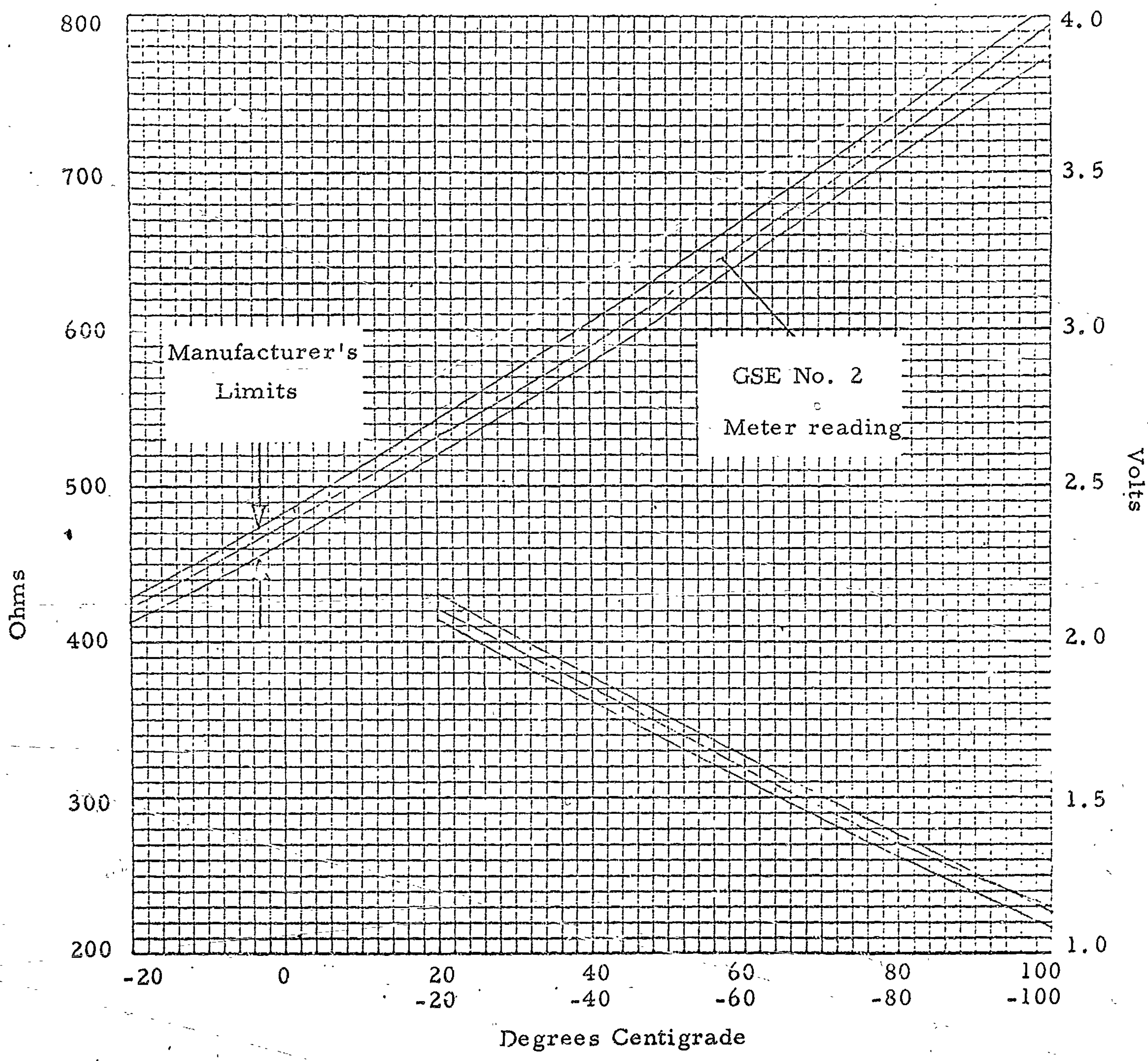


Figure 12. TEMPERATURE PROBE CALIBRATION CURVES

Two cross member shear webs are incorporated into each housing for internal rigidity and relieved with lighting holes to minimize weight. Relief cutouts were used on all exterior surfaces wherever possible to reduce weight without sacrificing the strength of the housings.

The two covers are also fabricated from AZ31B magnesium tooling plate. Four stifeening webs are designed into each cover to give support to the package when mounted cantilevered on the space-craft. Relief cutouts were also utilized on each cover to reduce weight without sacrificing strength.

The two housings and associated covers are entirely gold plated in order to obtain good electrical contact between the R-F gasketing mesh and the magnesium surfaces of the completed package.

All modules that are used in the logic unit were designed and fabricated by Marshall Laboratories. The modules are point-to-point welded and of the cordwood type construction. Components are positioned between two mylar wafers with their bodies in close physical proximity with one another and their leads parallel. The component leads are connected by means of welding interconnecting alloy 180 ribbon. The lead out wires from the module are also alloy 180, this material is used because of its non-magnetic properties. After electrical check of the module, they are dip coated with epoxy in order to provide greater resistance to environmental effects such as shock and vibration. The epoxy also provides an efficient means of conductive heat removal. The average size of the modules are .600 X .400 X .650 and the average weight 3.0 gram. The logic unit utilizes 76 welded modules of 29 different circuits.

A welded matrix was used for the interconnections required between modules. The welding process was decided upon because welding forms a permanent connection, whereas soldering suffers the weakness of a separable connection. In addition, welding is a stable process, which permits repeatability and control during fabrication. Welding also assures the reliability of assembled electronic components, because heat is localized in the joining process and is less likely to induce thermal damage.

The welded matrix consists of an epoxy glass support .016" thick on which the modules are mounted. An .031 epoxy glass spacer separates the support board from the matrix, the matrix consists of two layers of alloy 180 wires at right angles to each other, separated by .008" mylar film. Wires on one side of the mylar all run vertically and all wires on the other side run horizontally. Welds are made through holes in the mylar film in order to make connections between the perpendicular matrix wires. An .031" thick epoxy glass spacer separates" the bottom of the matrix from the interconnecting board which is .031" thick. Module lead out wires are inserted through holes in the support board and protrude through mating holes in interconnecting board. Interconnecting alloy 180 ribbon is welded between the module lead out wires and lead out wires from the matrix. Excess ribbon and lead out wires are clipped after welding. Terminals are swaged onto either the support board of interconnecting board for the termination of wires that lead out to the connectors.

After final calibration and electrical check, the completed matrix and module assembly was coated with solithane 113 a liquid urethane prepocymer. The unit was then foamed using eccofoam FPH a high temperature polyurethane, rigid, foam-in-place resin. To secure the electronics in each of the housings. This method was employed to maintain minimum weight and to meet the severe environmental requirements.

The completed package for the electronics of the logic unit measures 6.00" X 5.25" X 3.56" and weighs 1085 grams.

The packaging of the sensor electronics followed the same philosophy as that for the packaging of the logic unit. Magnesium was used in the fabrication of the housing and covers.

The sensor electronics with sensor plate mounted measures 10.00" X 2.25" X 9.34" and weighs 723 grams. The sensor plate was fabricated from aluminum alloy 6061-T651 and delivered to GSFC for the depositing of the films. The plate is isolated from the housing to which it is mounted by means of six silicone grommets. The initial prototype used silicone grommets with a Shore Durometer hardness of 50, the sensor assembly was vibrated at Jet Propulsion Laboratory to the Surveyor Vibration Specification. The results of the testindicated that the grommets were tearing away from their mounting holes. To alleviate this problem, the unit was refitted with silicone grommets that used a Shore Durometer hardness of 70, and an oversize flat washer was placed between the grommet and the bottom of the head of the mounting screw. The unit was again vibrated to the Surveyor vibration specification with the correction and the results being that the tearing of the grommets was eliminated.

The Surveyor Ejecta Detector GSE is packaged into s standard Optina Cabinet that measures 11 1/4" X 20" X 22". The electronics can be removed from the cabinet by pulling on the handles provided. The circuitry is distributed amount 80 modules which are welded onto three welded matrix assemblies. The three module matrix assemblies are accessible and independently removable from the main chassis. This is accomplished by having each module matrix assembly having individual pigtailed plug-in connectors that tie into the main harnessing. A nulling printed circuit board is located accessibly so that calibration and trimming of the potentiometers can be done with all other circuitry intact. All printed circuit boards and welded module matrices are protected by solithane 113.

A cable compartment is provided in the rear of the cabinet for the storing of cables and miscellaneous items. A box that can be plugged into the rear of the cabinet and extend to the front is provided for monitoring pertinent data points by means of test jacks.

APPENDIX A

NEW MODULES USED IN THE EXPERIMENT

The following circuits were designed for the Surveyor Ejecta Detector. The design goals included operation of analog circuits within 1 percent of room temperature value over a temperature range of -55°C to +100°C. The additional limitations were space and power. They are listed numerically with increasing part number.

W233-7 One Shot Module.

This module was designed to have the characteristics of the W230 one shot module, with additonal components R2 CR1, CR2 and CR3 added to give this module maximum noise rejection. The noise voltage on any line has to exceed at least 0.5 volt before triggering will occur. Resistor R2 and diode CR1 relieve collector load R1 of capacitance C1 and enables the collector waveform recovery time to be minimum.

W4151 Low Level Amplifier.

This module is used to amplify the microphone signals in the first three stages of the mic channel. It has an nominal gain of 10 which is established by the ratio of R6 to R7. It operates well above the 3 db frequency of the transistors; that is, the current drain of both transistors [illegible] minimized so as to conserve power. The total power dissipated in this stage is 1.8 milliwatts. The stability of this stage is nominally 1% over the -55°C to 100°C temperature range. The input impedance is approximately 70K and the output impedance is approximately 300 ohlms.

W4152 and W4153 High Speed Comparator Modules.

This circuit was designed to operate at data rates up to 500 KC It consists of a differential amplifier stage and emitter follower isolation state. A PNP amplifier stage driver state speed is achieved through clamping the collector waveforms of the first differential amplifier stage with diodes CR1 and CR2, thereby limiting the charging of the stray capacitances in the circuit. Additional clamping occurs in diodes CR3 and CR4. The outputs of this comparator are Pin 7 and Pin 12 of W4153. When a positive signal is applied to input A of W4152, output Q will go to a one. Output $\bar{Q}$ will go to a zero. Similarily, if a positive signal is applied to input B on W4152, output $\bar{Q}$ will go to a one. The power dissipated in these two modules is 14.7 milliwatts on the +12, 1.68 milliwatts on the +6 v supply and 11.0 milliwatts on the -7 v, giving a total power dissipation of 27.4 milliwatts.

W4154 And Logic Module.

This is an noninverting gate requiring coincidence at the input for an output one. It is used to obtain a very fast leading edge on positive going waveform. It is designed for a +3 v power supply and is used to drive gated clock module W4159. Since both transistors are normally in the off state, the power dissipation in this module is caused by that current through R1, and is approximately 30 microwatts.

W4155 Parallel AND Logic Gate Module.

This is essentially the same as W4154; the collector load on Q2 has been omitted so that one or more of these modules may be in parallel at the output to form the "OR" function.

W4157 Command Interface Module.

This module is essentially a one shot. The input trigger level has been adjusted. The input impedance has been increased by the addition of R7 in the input line. The level at which the one shot triggers is established by the voltage divider R4, CR3, R5 and R6.

W4158 Sure Starting Clock Module.

This module is an astable multivibrator which was designed to run at 100 cycles per second continuously. This clock overcomes the difficulty of some astable multivibrators, which saturate both transistors immediately upon power turn-on. The nonsaturation of both transistors is accomplished by the choice of values of resistor R1 and the collector loads R5 and R4. If both transistors were saturated, the potential across R1 would be such that it would exceed either of the potentials at R4 or R5, thereby the transistors would have to be paradoxically turned-off. Therefore, since both cannot saturate, one of the transistors will be turned on and the other turned off after power turn-on. Transistor Q3 is a isolating amplifier which drives switch Q4 to a 3v logic level. This clock is designed to maintain a frequency stability of better than 1% over the temperature range of -55°C to +100°C.

W4159 Gated Clock Module.

This clock was designed to start very rapidly upon receipt of a clock control signal and is used in the pulse analyzer section where delay times in starting the gated time must be minimized since it is utilized in a pulse height to time conversion. This minimal delay is achieved by coupling the leading edge of the applied clock control pulse through transistor Q4 to the base of transistor Q1 which is to be turned on. Q1 immediately saturates, turning Q2 off. This signal results in a positive-going signal applied to the base of Q3, the saturating switch. The collector of Q3 is the output of the module. Upon application of the clock control pulse to Pin 11 the output at Q3 goes negative. The output is a square wave at the frequency determined by the external capacitors which are applied across Pins 3, 7, 12 and 9.

W4160 Final Amplifier Module.

This amplifier, which has a gain of 10, is the final stage in the microphone amplifier channel. Its input impedance is in excess of 70K and its output impedance is less than 300 ohlms. The output has a wide dynamic swing accommodating signals within 50 millivolts to 2.5 volts. Its power dissipation is +1.8 milliwatts.

W4167 Detector Module.

This module is used in the microphone channel to detect peaks of the incoming wave. The input is applied through Pin 17 and C1 to one side of a matched pair differential amplifier transistor Q1. The other side of the differential pair is driven from the feedback network through amplifier stages Q2 and Q3. The output is taken off of the second base of the differential pair and appears across an external capacitor which charges to the highest level of the incoming signal. Since the feedback around the amplifier results in unity gain, the output level is equal to the input signal peak. The base drive of transistor Q3 is sufficient to charge the external capacitor at 100 KC rate. The detector is stable to within 1% over the -55°C to 100°C range.

W4168 Inhibit and Hold Module.

The inhibit portion of this module operates on a positive pulse applied at Pin 5 which causes Q1 and Q2 to conduct and saturate. The current through Q2 causes a large current in the output line of Pin 6 which comes from the common emitter point of detector module W4167. This effectively clamps the common emitters of the W4167 module at a high potential thereby disabling that detector from receiving further information. When the inhibit command is at a zero level, transistor Q2 is turned off; therefore, no current flows through R7 and the output lead. The hold section of this module operates on a positive command on Pin 8, turning transistor Q5 on, and thereby turning transistor Q4 off. When transistor Q4 turns off,the output transistor Q3 is also turned off and no current flows through the output lead in Pin 7. This output lead is attached through a resistor to the integrating capacitor at the output of the detector module. When current flows through transistor Q3, the capacitor is discharged. In the event that a hold signal is not present, transistor Q3 is conducting thereby maintaining the capacitor at the output of the detector continuously discharged.

W4169 Gain of Two Amplifier Modules.

This module is very similar to final amplifier module W4160. It is used in the microphone channel and its signal is taken from the output of the detector. The use of the gain of two relieves the detector of having to perform over an excessively large dynamic range.

W4170 SCO Driver Module.

This module is a three stage inverting amplifier which is used to condition the three volt logic level signals received at the output of the telemetry coding section and converts the signals to 6-volt-to-0 volt logic levels, with accurately controlled rise and fall times.

W4171 Trigger Module.

This module is a level detector circuit, the threshold level being established by resistors R2, CR1 and R5. If the level at the input drops below a given value, transistor Q1 will conduct causing transistor Q2 to go to a zero.

W4172 Integrator Module.

This module consists of an inverting amplifier stage which drives the integrating capacitor and a dual transistor feedback-type emitter follower. A high data rate of positive pulses applied at the input and hence to Q1, causes Q1 to discharge an external capacitor connected between Pin 7 to B+, thereby causing the DC level at the base of Q2 to drop. The DC level is transmitted at the output at a very low impedance to drive a logic circuit.

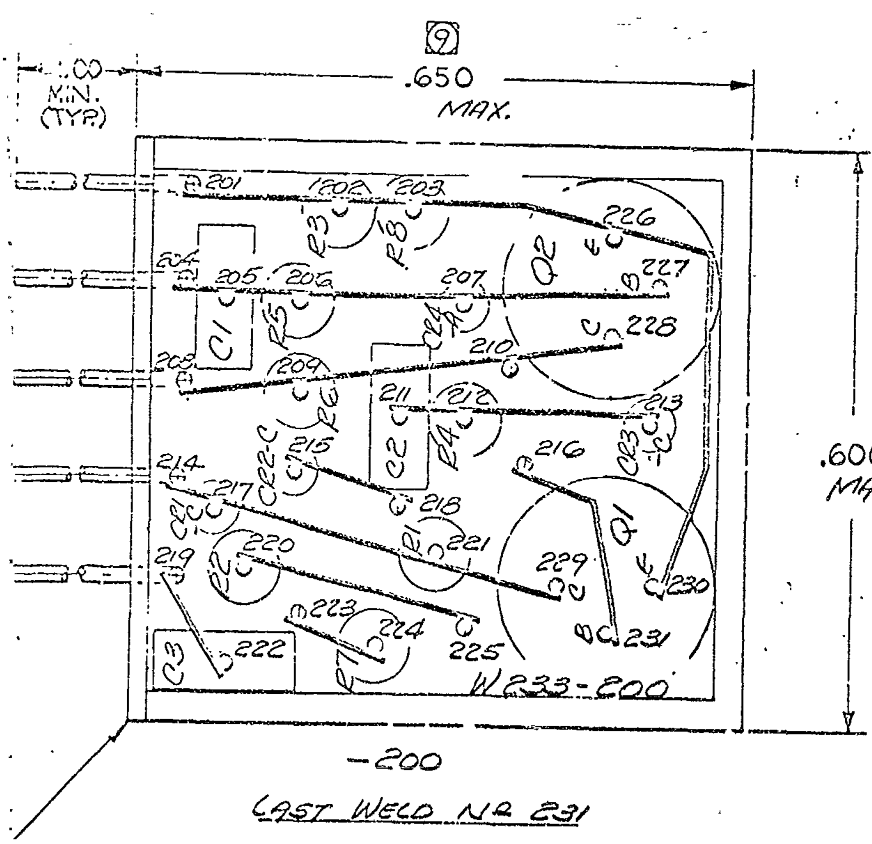
W4176 Detector Module.

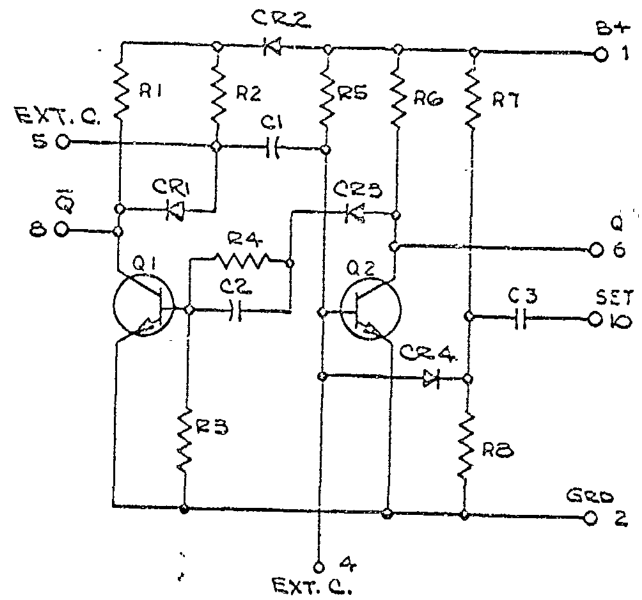
This module is used to peak detect the film signal. It is designed to follow a very rapid rise time and to offer a high impedance to the charged capacitor, so that its discharging time constant will be very long. The high impedance is realized by the use of emitter follower matched pair differential transistor Q1 which is inserted in the closed feed back loop consisting of Q2 and Q3. This detector has a wide dynamic range and is capable of handling signals up to 5 volts.

W233

REVISIONS

...MPONENTS & HEADER
...ITTED FOR SIMPLICITY





ELECTRONIC SCHEMATIC

W233

SEE SEPARATE LIST OF MATERIAL

ITEM	PART NO	DESCRIPTION	QTY
		LIST OF MATERIALS	

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES

HOLE DIA.	TOLERANCE	LINEAR TOLERANCES
.0135 THRU .125	+.004-.001	.XXX = ±.010
.126 THRU .250	+.005-.001	.XX = ±.03
.251 THRU .500	+.006-.001	.X = ±.1
.501 THRU .750	+.008-.001	ANGLES = ±0°30'
.751 THRU 1.000	+.010-.001	SURFACE ROUGHNESS
1.001 THRU 2.000	+.012-.001	PER ...
2.001 AND OVER	LINEAR	

NEXT ASSY | USED ON | NEXT ASSY | FINAL ASSY
APPLICATION | QTY REQD

FINISH
HEAT TREAT

ONE SHOT MODULE

RELEASED 7 APRIL 64

MARSHALL LABORATORIES

SIZE D | W233

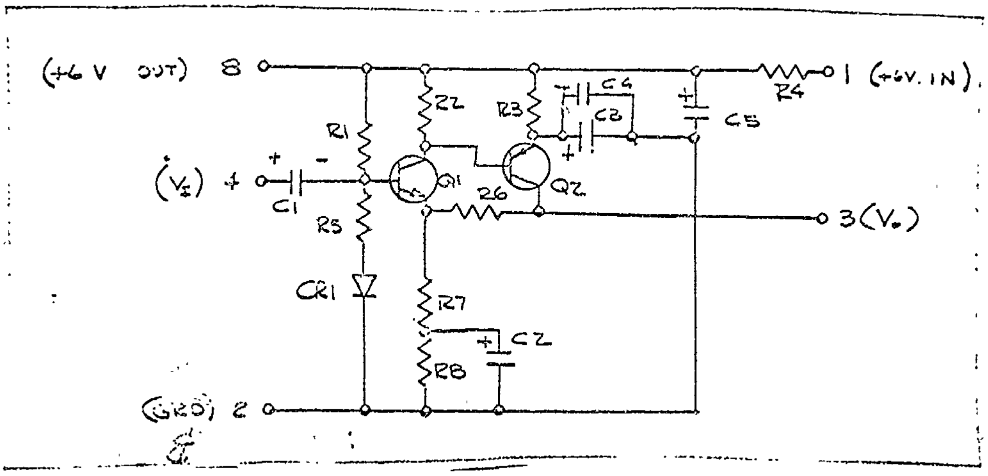
SCALE 10/1 | SHEET 1 of 1

MFG CODE ...

W4151 A

REVISIONS

			DESCRIPTION		DATE		
4		A	REMOVED PIN 18, SHIELD GRD IS NOW PIN 2				



W4151

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED

DIMENSIONS IN INCHES

LIST OF MATERIALS

APPLICATION

QTY REQD

ANGLES ±0°30'

LOW LEVEL AMPLIFIER

MARSHALL LABORATORIES

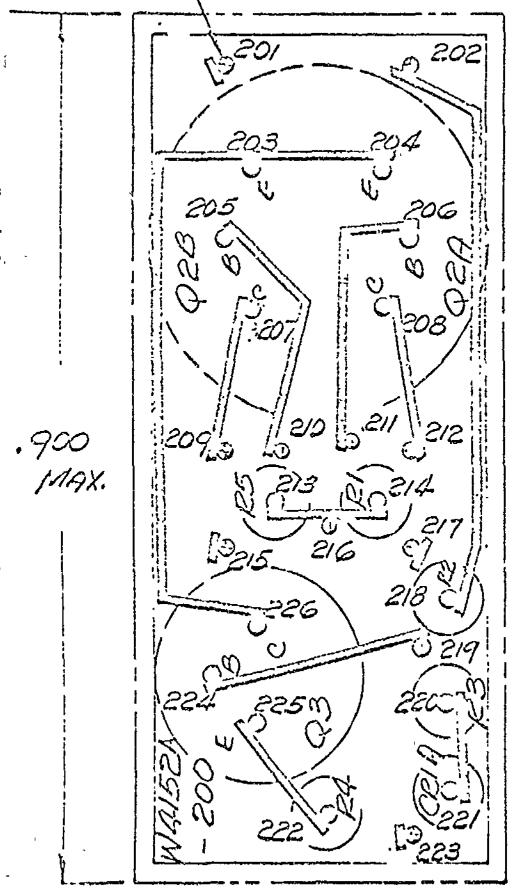
D W4151 A

	W4152	4

REVISIONS

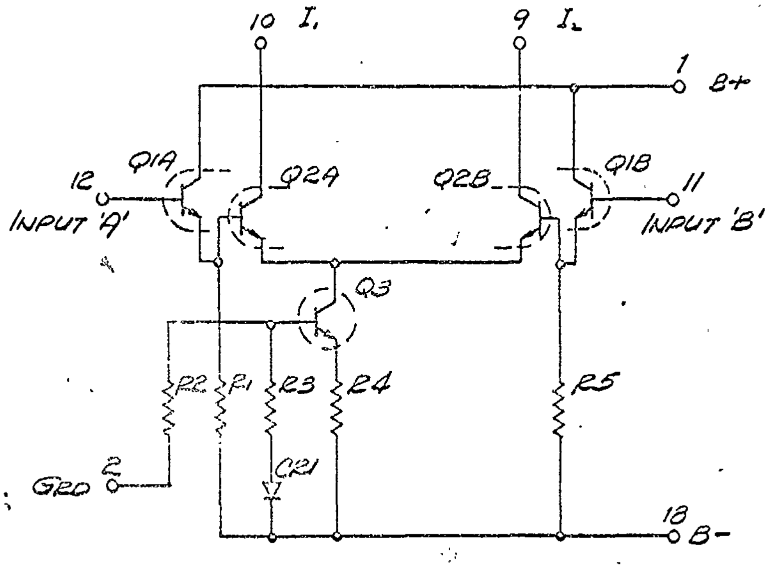
4	1EUP	A	REVISED RIBBON SIZE	RP	

LEAD Nº 1



W4152-200

LAST WELD Nº 226



ELECTRONIC SCHEMATIC

W4152
A

SEE SEPARATE LIST OF MATERIALS

LIST OF MATERIALS

RELEASED APR 9 196?

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES

ANGLES ±0°30'

HIGH SPEED COMPARATOR INPUT MODULE

MARSHALL LABORATORIES

W4152 A

W4153

REVISIONS

ZONE	LTR	SYM	DESCRIPTION	BY	DATE
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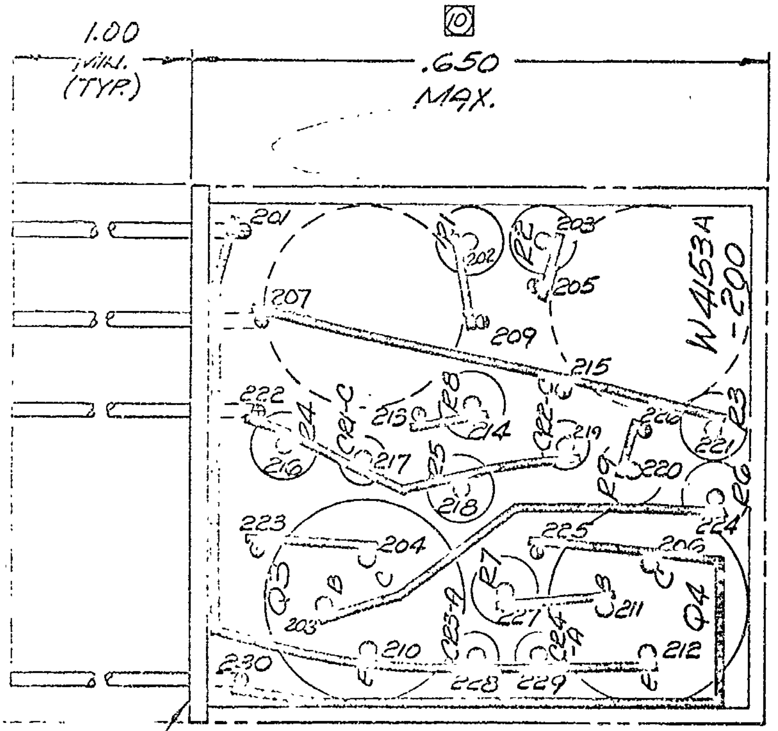
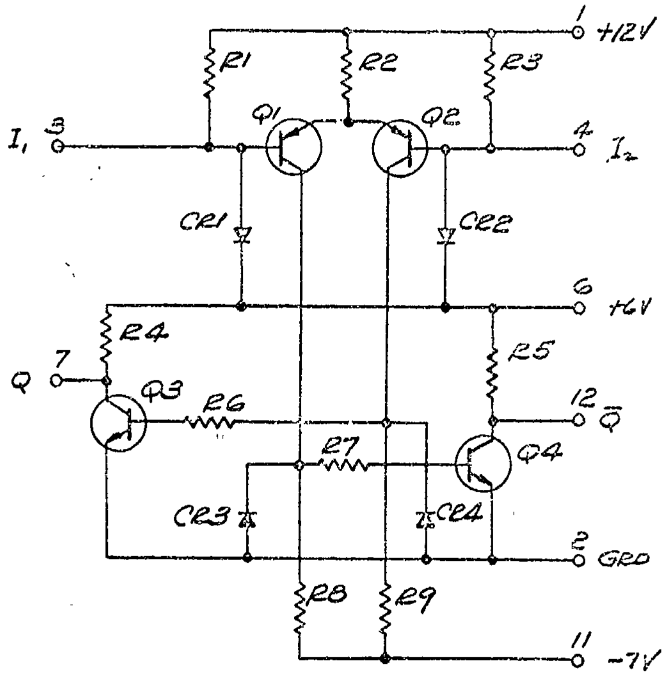


W4153 – 200

LAST WELD No 230



ELECTRONIC SCHEMATIC

W4153

SEE SEPARATE LIST OF MATERIAL

LIST OF MATERIALS

DO NOT SCALE DRAWING

RELEASED APR 9 1964

HIGH SPEED COMPARATOR OUTPUT MODULE

MARSHALL LABORATORIES

D W4153 A

PARTS DISPOSITION		W4154	A
1. USE 2. REWORK	3. CANNOT BE REWORKED 4. RECORD		

REVISIONS

ZONE	EFF	SYM	DESCRIPTION	BY	DATE	CK'D	APPROVAL
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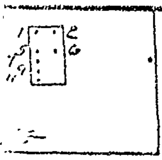
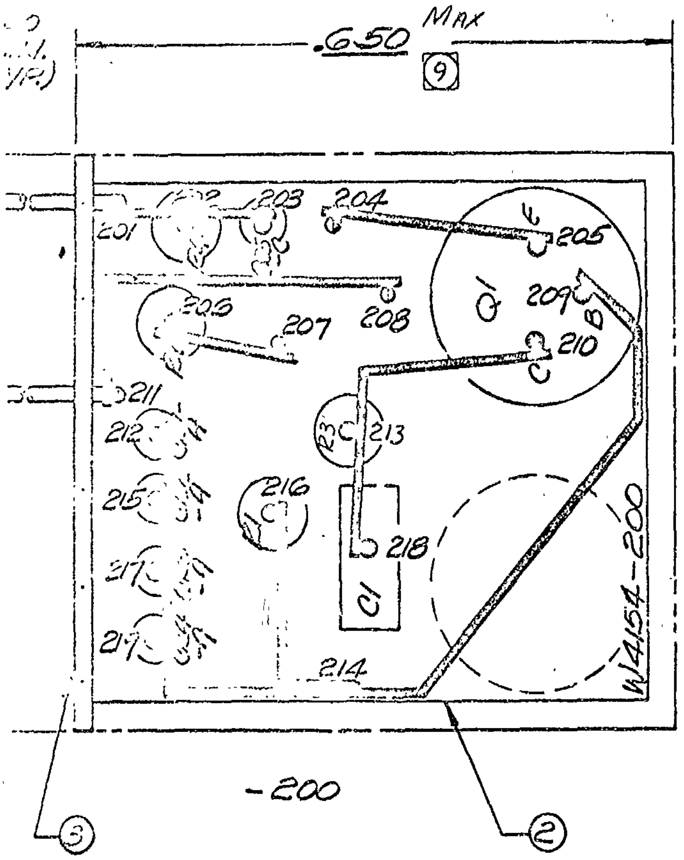
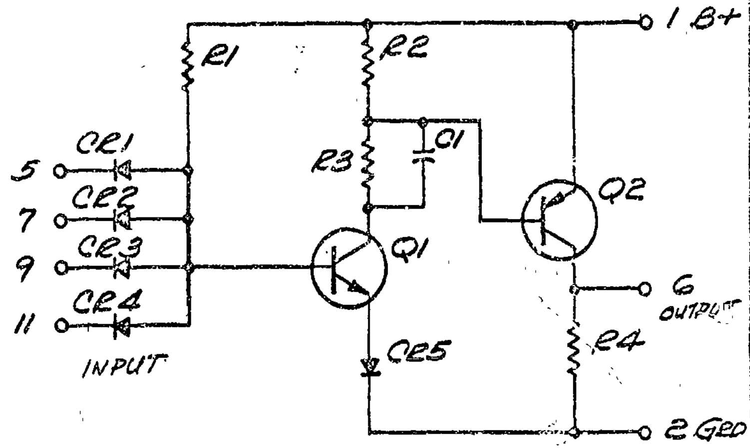


: HEADER
: SIMPLICITY



LAST WELD No 219



ELECTRONIC SCHEMATIC

W4154 A

SEE SEPARATE LIST OF MATERIALS.

REQD	PART NO	DESCRIPTION	CAT	ITEM
		LIST OF MATERIALS		

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES

HOLE DIA.	TOLERANCE	LINEAR TOLERANCES
.0135 THRU .125	+.004-.001	.XXX = ±.010
.126 THRU .250	+.005-.001	.XX = ±.03
.251 THRU .500	+.006-.001	.X = ±.1
.501 THRU .750	+.007-.001	ANGLES = ±0°30'
.751 THRU 1.000	+.010-.001	SURFACE ROUGHNESS
1.001 THRU 2.000	+.012-.001	PER MIL-STD-10
2.001 AND OVER	LINEAR	

NEXT ASSY | FINAL ASSY
QTY REQD

FINISH
HEAT TREAT

RELEASED APR 9 1964

AND LOGIC GATE MODULE

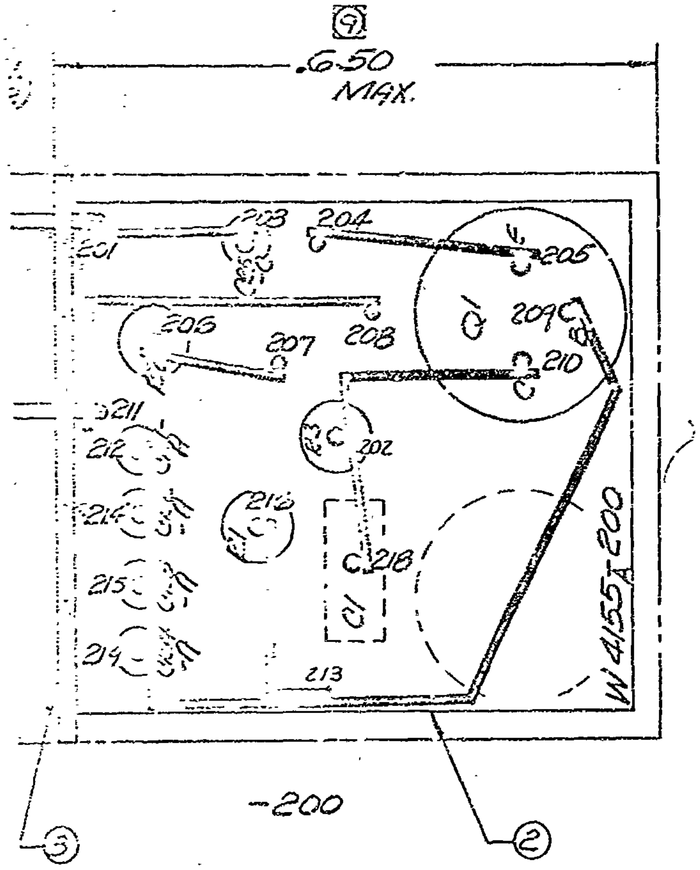
MARSHALL LABORATORIES

SIZE D | W4154 | A
SCALE 10/1 | WEIGHT | SHEET 1 OF 1

PARTS DISPOSITION	W 4155	A
1. USE 2. REWORK 3. CANNOT BE REWORKED 4. RECORD		

REVISIONS

SYM	APP	LTR	DESCRIPTION	BY	DATE	APPROVAL
A	1FUP	A	REVISED RIBBON SIZE	RP		



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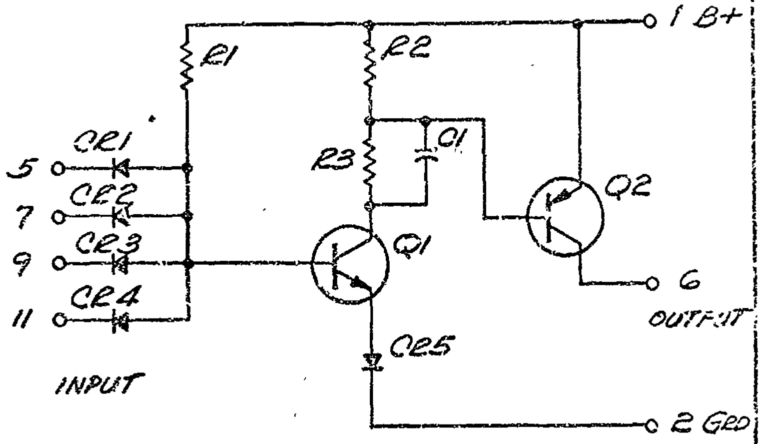


ELECTRONIC SCHEMATIC

W 4155 A

SEE SEPARATE LIST OF MATERIALS.

LIST OF MATERIALS

RELEASED APR 9 1964

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES

PARALLEL AND LOGIC GATE MODULE

MARSHALL LABORATORIES

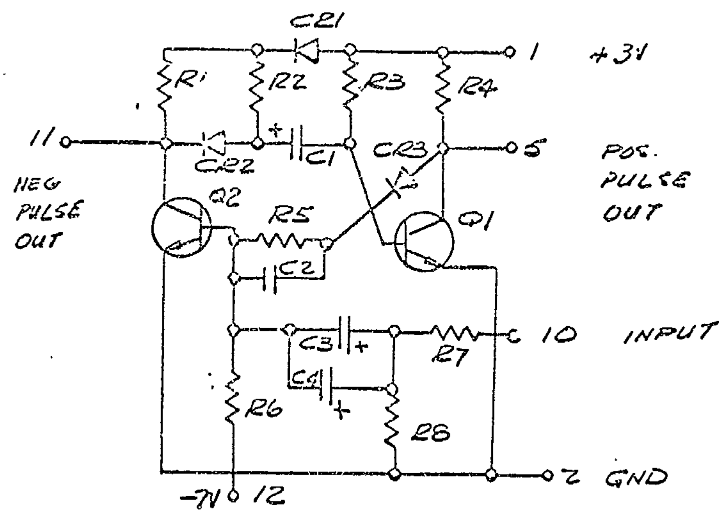
D W 4155 A

SHEET 1 OF 1

SCALE 10/1

V/4157

REVISIONS



ELECTRONIC SCHEMATIC

V/4157

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED

DIMENSIONS IN INCHES

LIST OF MATERIALS

RELEASED APR 24 1964

COMMAND INTERFACE MODULE

MARSHALL LABORATORIES

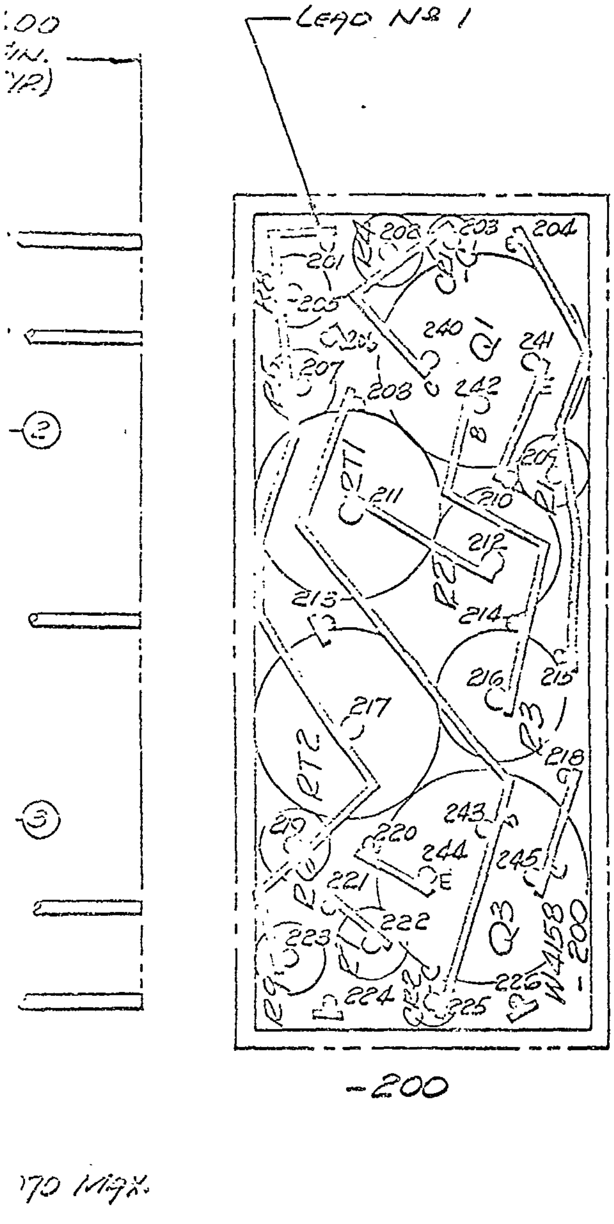
D V/4157

SCALE 10/1

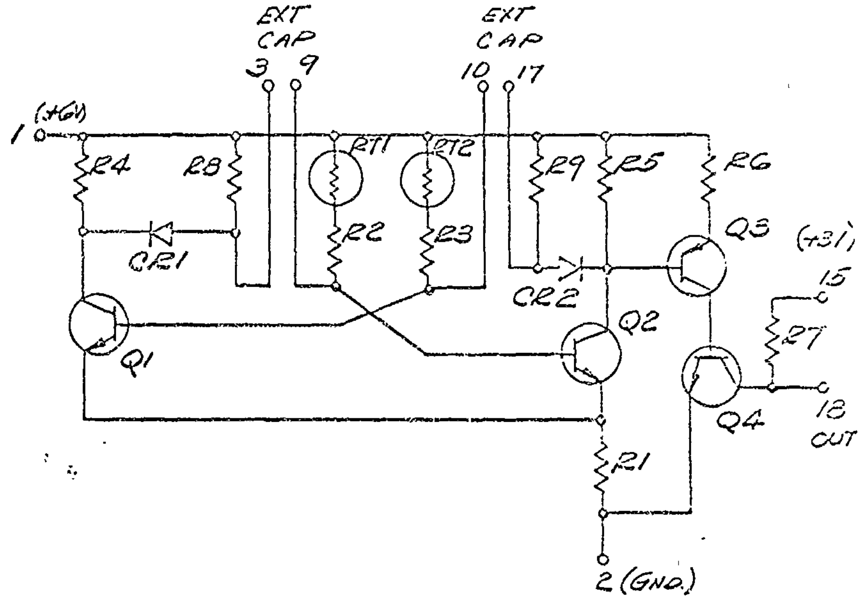
SHEET 1 OF 1

W4158

REVISIONS



-200



ELECTRONIC SCHEMATIC

WELD NO.	USED	DELETED
-100	101 → 133	—
-200	201 → 226, 240 → 245	227 → 239

W4158

SEE SEPERATE LIST OF MATERIAL.

LIST OF MATERIALS

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES

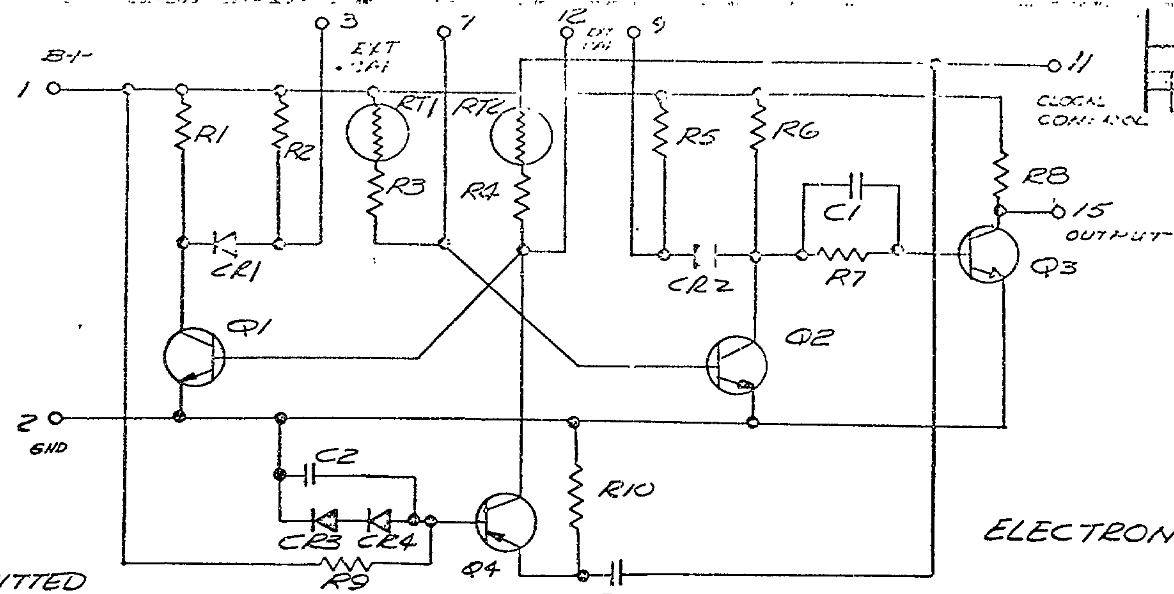
LINEAR TOLERANCES
.XXX = ±.010
.XX = ±.03
.X = ±.1

SURE STARTING CLOCK MODULE (.750)

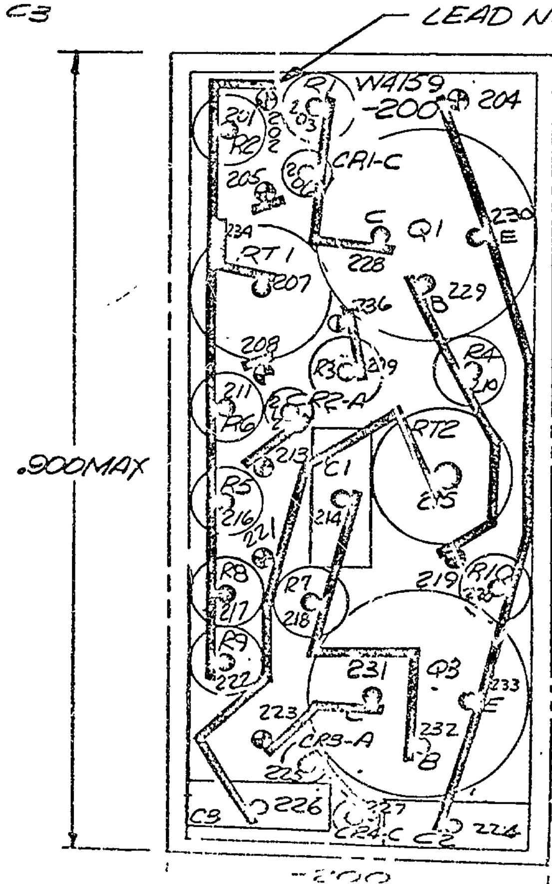
MARSHALL LABORATORIES

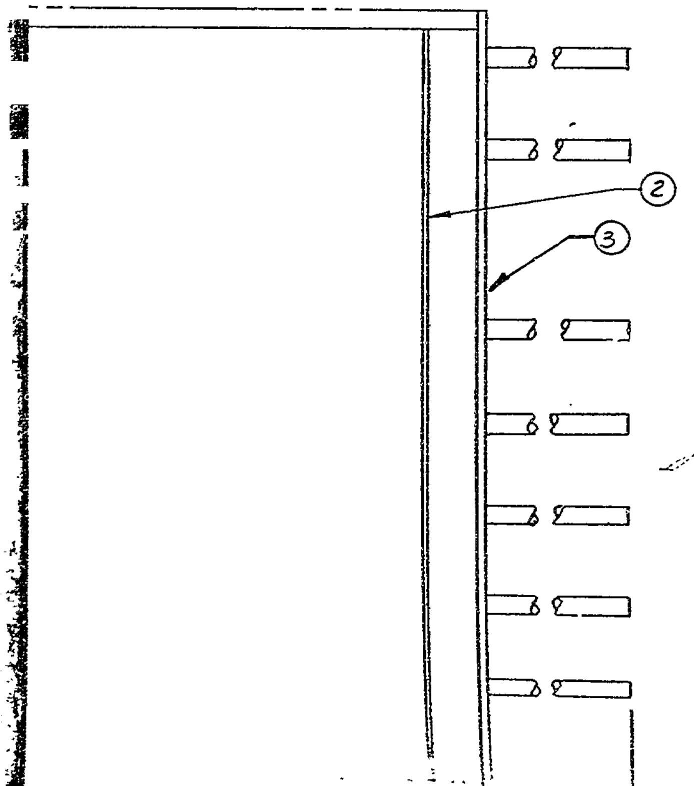
D W4158

SHEET 1 OF 1



ELECTRONIC SCHEMATIC





MPONENTS OMITTED
CLARITY

WELD NO. USED
-100: 101 – 133
-200: 201 – 234

W4159

W4159

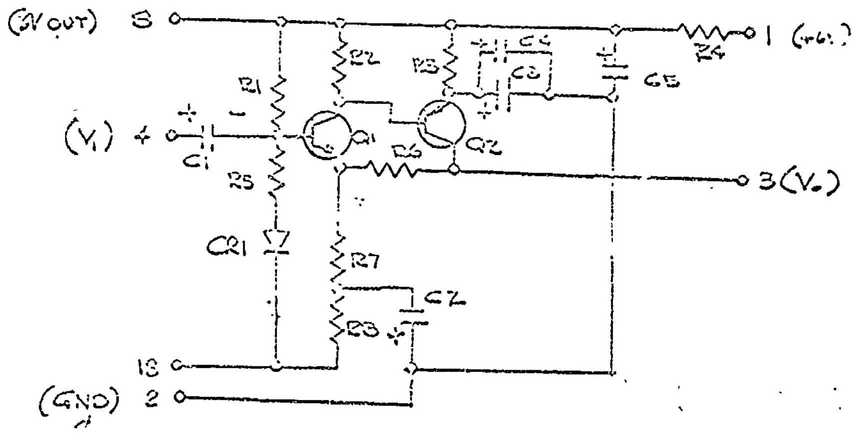
REVISIONS

SIZE

W4160

REVISIONS

4	1 UP	A	REMOVED PIN 16, SHIELD GRD IS NOW PIN 2	B.			



W4160

DO NOT SCALE DRAWING

LIST OF MATERIALS

RELEASED APR 28

FINAL AMPLIFIER MODULE

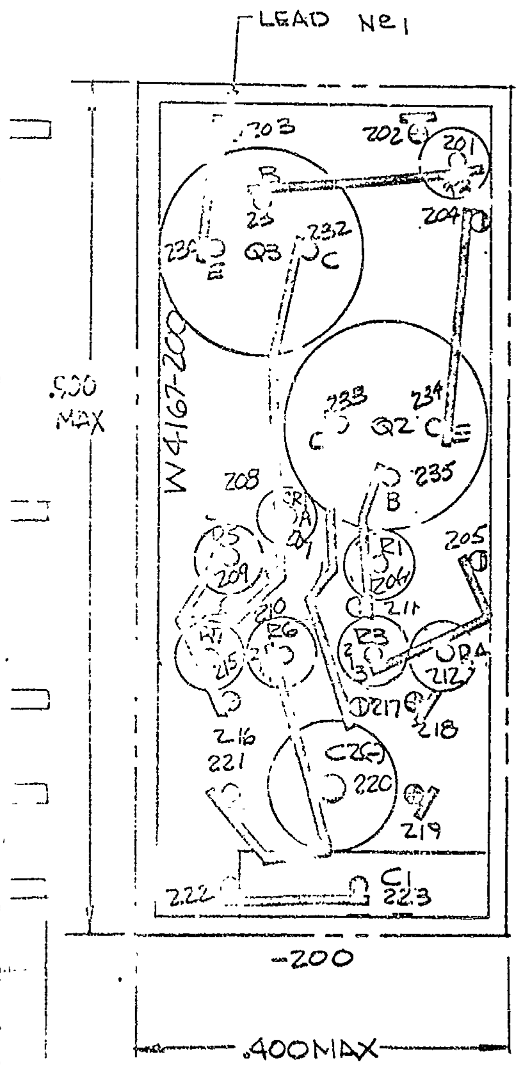
MARSHALL LABORATORIES

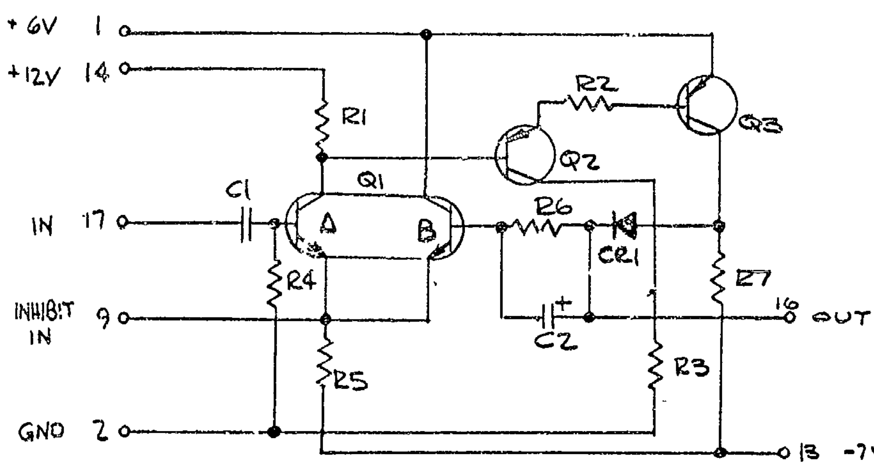
W4160

PARTS DISPOSITION 1. USE 2. REWORK 3. CANNOT BE REWORKED 4. RECORD	W4167

REVISIONS

SYM	EFF	SYM	DESCRIPTION	BY	DATE	CK'D	APPROVAL





ELECTRONIC SCHEMATIC

WELD NO. USED	DELETED
-100 101-129	
-200 201-222,230-235	

W4167

SEE SEPARATE L/M

REQD	PART NO	DESCRIPTION	CAT REF	ITEM
LIST OF MATERIALS				

FINISH

HEAT TREAT

DO NOT SCALE DRAWING

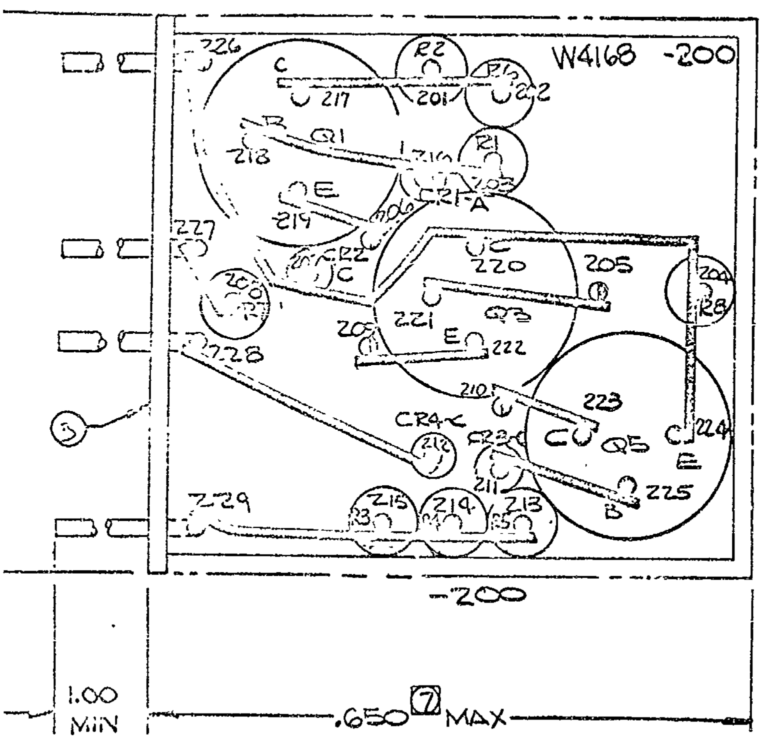
UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES

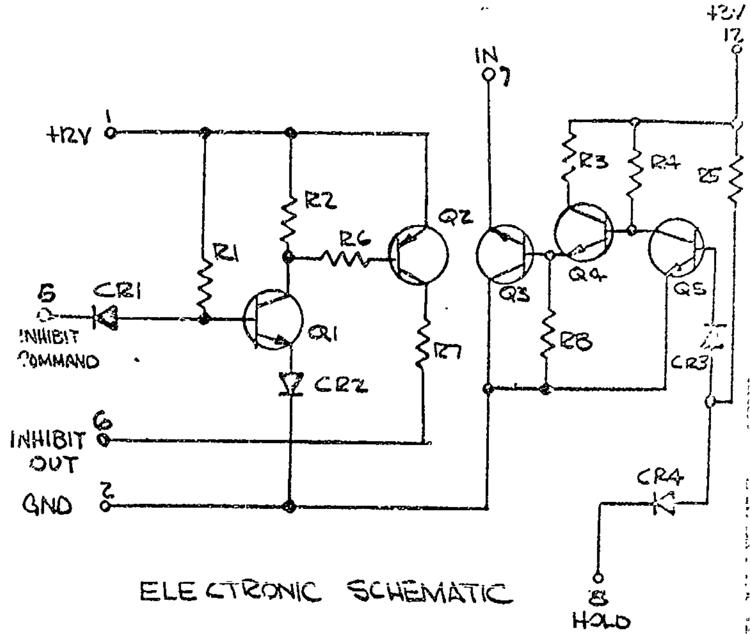
DETECTOR MODULE

SIZE D W4167 SHEET 1

REVISIONS	W4168

...ENTS
...PLICITY





ELECTRONIC SCHEMATIC

WELD No USED
-100: 101-127
-200: 201-229

W4168

LIST OF MATERIALS

RELEASED APR 24 1964

INHIBIT & HOLD MODULE

MARSHALL LABORATORIES

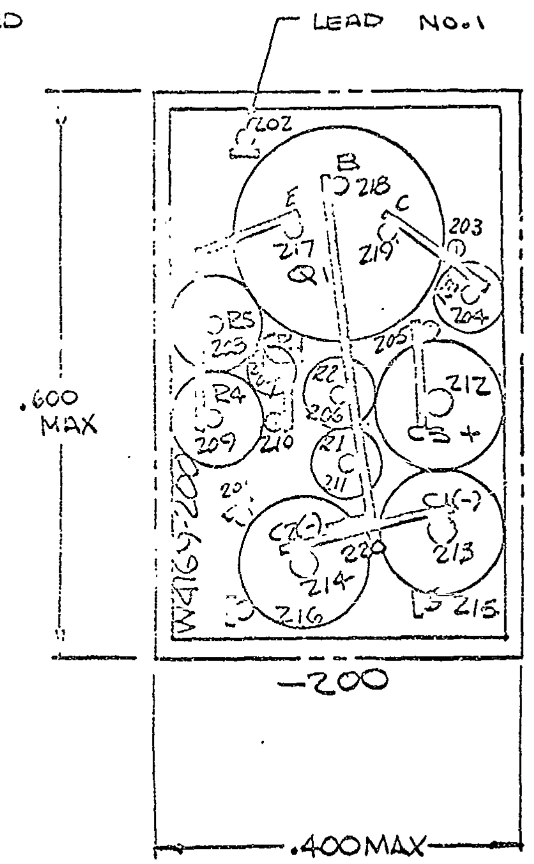
D W4168

SCALE 10/1

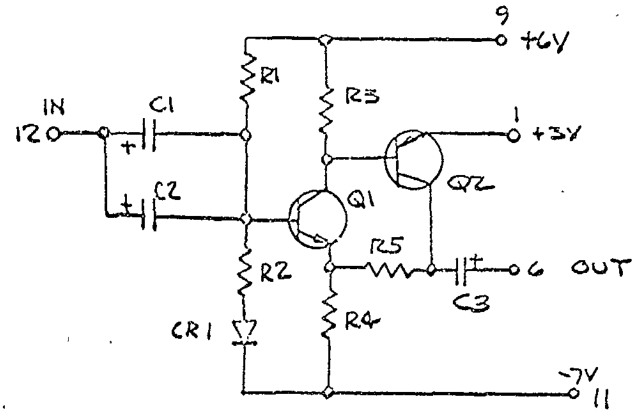
SHEET 1 OF 1

W4169

REVISIONS



WELD № USED
-100: 101-124
-200: 201-220



ELECTRONIC SCHEMATIC

W4169

LIST OF MATERIALS

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES

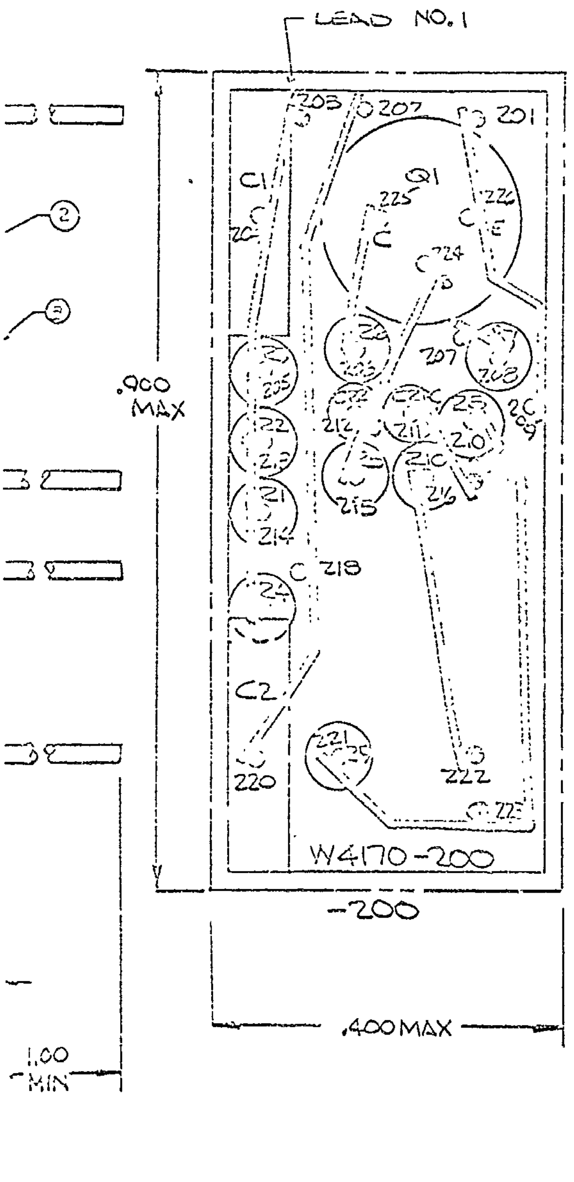
APR 24 1964

GAIN OF TWO AMPLIFIER MODULE

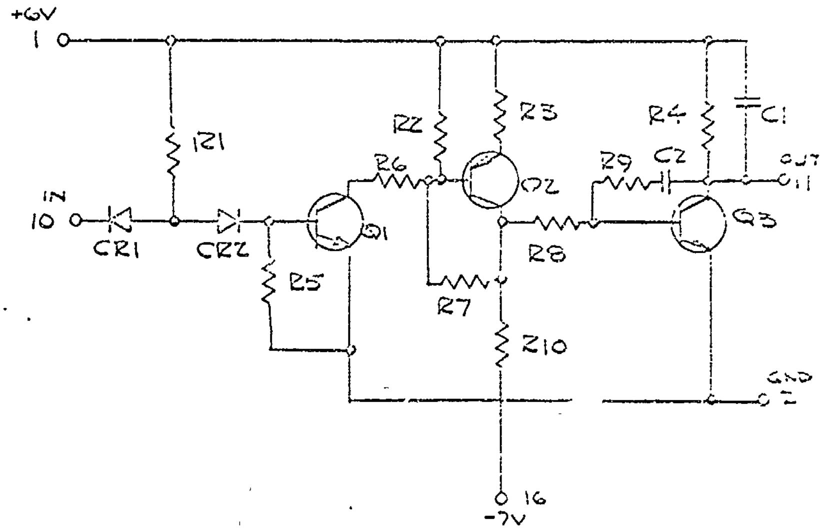
MARSHALL LABORATORIES

D | W4169

SCALE 10/1



WELD NO. USED
-100: 101-131
-200: 201-226



ELECTRONIC SCHEMATIC

W4170

LIST OF MATERIALS

DO NOT SCALE DRAWING

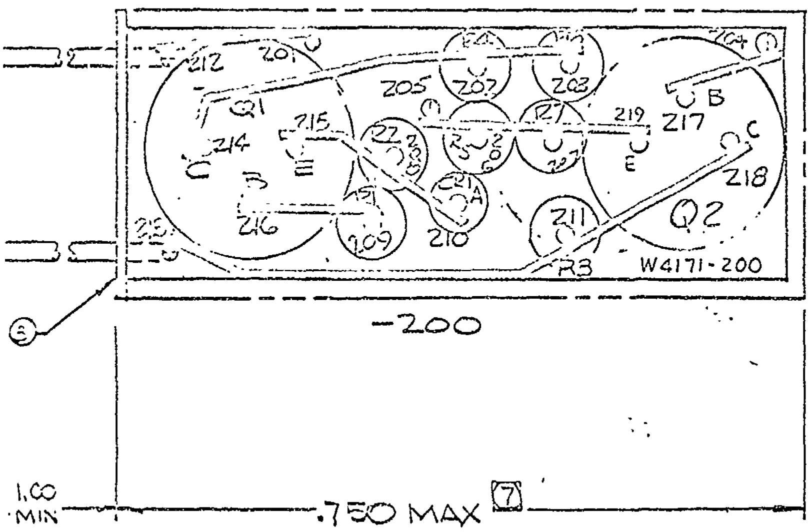
SCO DRIVER MODULE

MARSHALL LABORATORIES

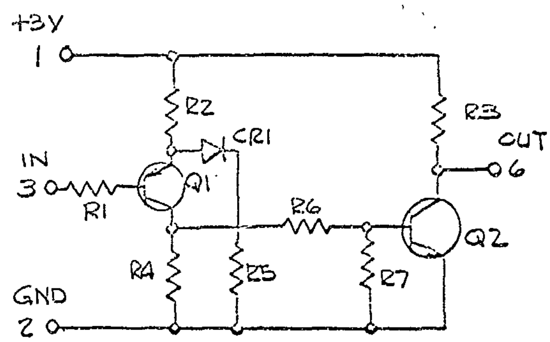
D W4170

W4171

REVISIONS



ELECTRONIC SCHEMATIC



WELD NO. USED
-100: 101–114
-200: 201–219

W4171

DO NOT SCALE DRAWING

LIST OF MATERIALS

RELEASED APR 28 1964

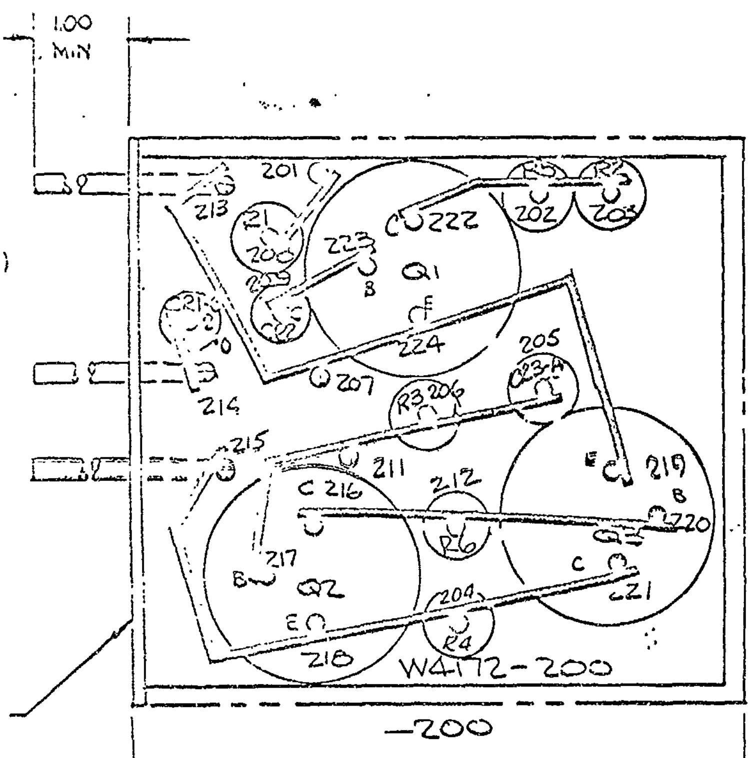
TRIGGER MODULE (.750)

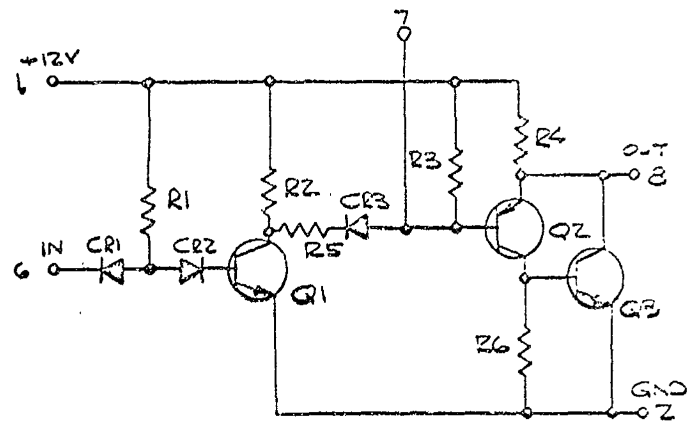
MARSHALL LABORATORIES

W4171

W4172

REVISIONS





ELECTRONIC SCHEMATIC

WELD · № USED
—100: 101-115
-200: 201-224

W4172

SEE SEPARATE L/M

LIST OF MATERIALS

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED

INTEGRATOR MODULE

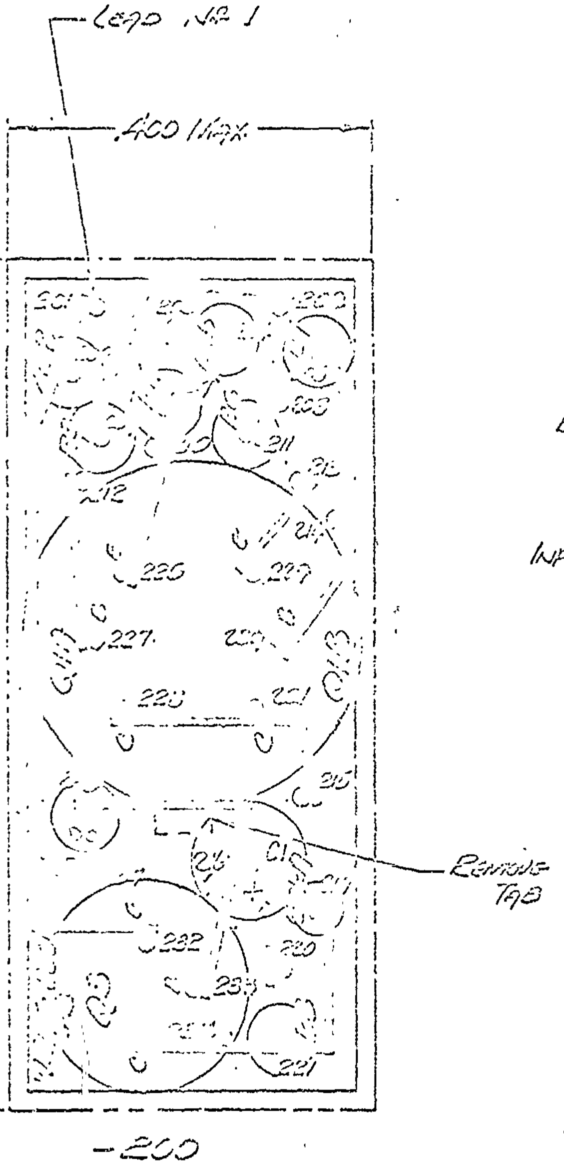
W4172

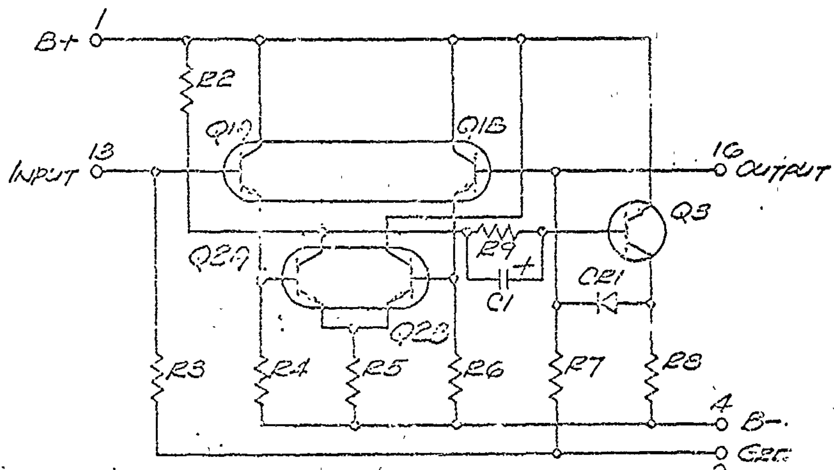
D

W4176

REVISIONS

2	14UP	A	REVISED CIRCUIT, DELETED R1, [illegible]	[illegible]	[illegible]	[illegible]
4	17DP	B	REVISED LOCATION R9 & C1; C1 WAS VITAMIN TYPE	R.P.	[illegible]	[illegible]





ELECTRONIC SCHEMATIC

W4176

B

WELD NO.	USED:	DELETED
-100	[illegible]	—
-200	[illegible]	—
-300	[illegible]	—

LIST OF MATERIALS

RELEASED APR 24 1964

DETECTOR MODULE

MARSHALL LABORATORIES

APPENDIX B

NEW MODULES USED IN THE GSE

GW 4211

GW 4212

GW 4216

GW4211 AND-NOR Logic Gate Module.

This module consists of AND gate CR1, CR4 and R1 with the output on Pin 9. A 2-input NOR circuit consists of CR5, CR7, CR6 Q1, R3 and R2. The output of the NOR is Pin 6.

GW4212 AND-OR Logic Module.

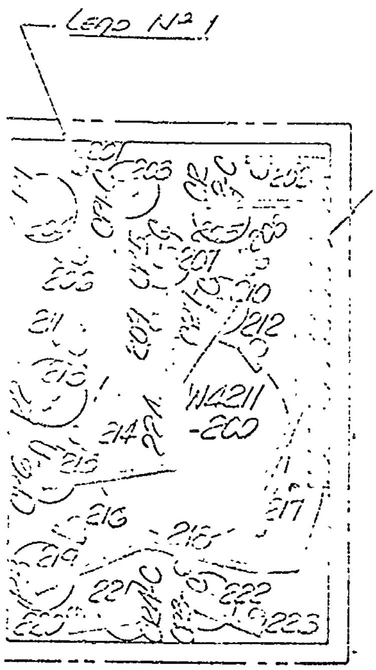
CR1, CR2, CR3 and R1 form one AND circuit. CR4, CR5 and CR6 and R2 form another AND circuit. CR7 and CR8 are used to sum the outputs of two AND gates to provide the OR function.

GW4216 Sensor Line Driver Module.

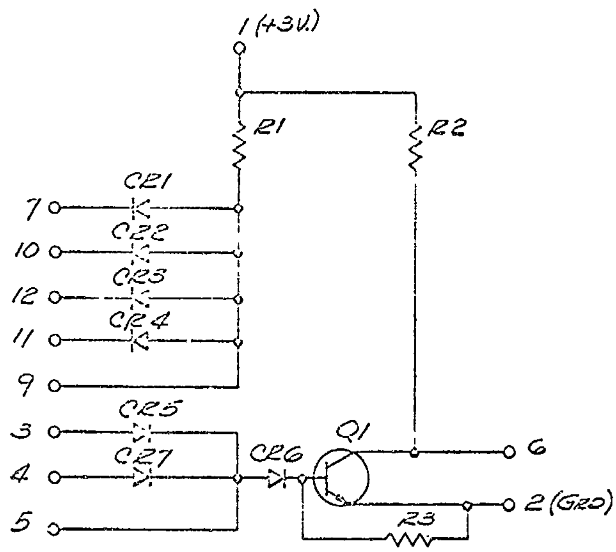
This module is driven by a saturating PNP transistor which forms a fast leading edge. The module inverts the signal to produce a fast negative going pulse. The amplitude of the pulse is determined by the value of the variable B+.

W4211

REVISIONS



-200



ELECTRONIC SCHEMATIC

WELD NO. USED:		DELETED
-100	101 — 123 125 — 128	—
-200	201 — 224	—

W4211

DO NOT SCALE DRAWING

LIST OF MATERIALS

RELEASE JUL 21 1964

AND - NOR LOGIC GATE MODULE

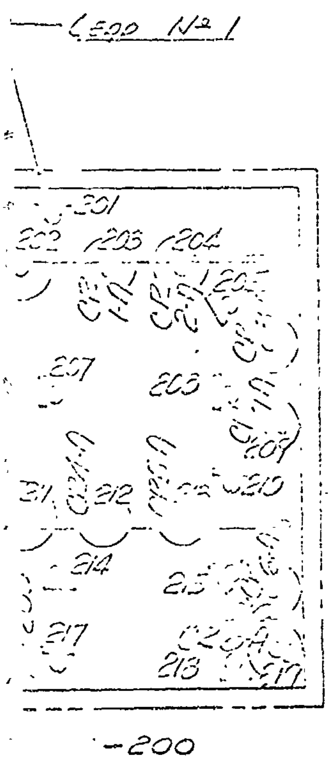
MARSHALL LABORATORIES

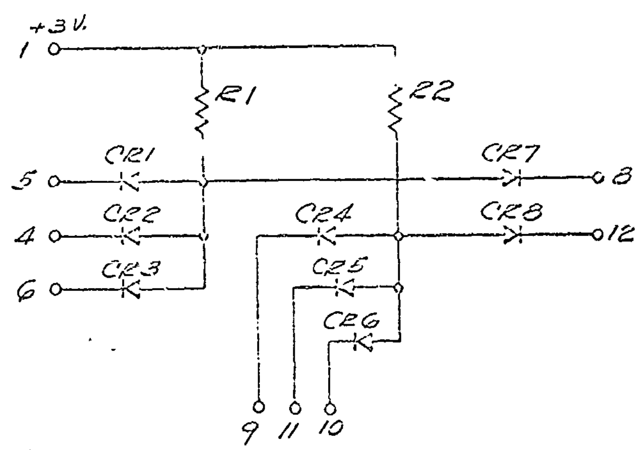
D W4211

SHEET 1 OF 1

W4212

REVISIONS





ELECTRONIC SCHEMATIC

WELD NO. USED		DELETED
-100	101 —— 119	—
-200	201 —— 219	—

W4212

DO NOT SCALE DRAWING

LIST OF MATERIALS

AND-OR LOGIC GATE MODULE

MARSHALL LABORATORIES

D W4212

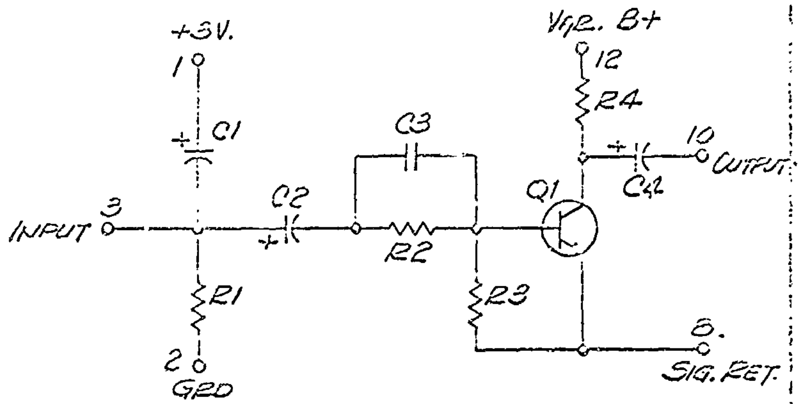
SCALE 10/1

SHEET 1 OF 1

W4216

REVISIONS

-200



ELECTRONIC SCHEMATIC

WELD NO.	USED:	DELETED
-100	101 → 117	—
-200	201 → 214	—

W4216

DO NOT SCALE DRAWING

LIST OF MATERIALS

RELEASE JUL 1 1964

SENSOR LINE DRIVER MODULE (.750)

MARSHALL LABORATORIES

D W4216

SCALE 10/1

SHEET 1 OF 1

APPENDIX C

SPECIFICATIONS AND MASTER DRAWING LISTS

This section contains the following released documents:

S40533 Micrometeorite Ejecta Detector (GSE Surveyor) NL 260-1, Test Procedure for

S40534 Circuit Board Assembly - Digital Readout and Command (GSE Surveyor) Test Procedure for

S40535 Circuit Board Assembly - Power Supply (GSE Surveyor) Test Procedure for

S40536 Circuit Board Assembly - Sensor Stimulus (GSE Surveyor) Test Procedure for

S40519 Surveyor Power Supply Blivet, Test Specification for

S40548 Surveyor Digital Blivet, Test Specification for

S40660 Surveyor Sensor Blivet, Test Specification for

S40682 Ejecta Detector (GSE Surveyor) ML 260-1, Operational Manual for

MDL No. 51117, Electronics Assembly

MDL No. 51259, Sensor Assembly

MDL No. 51304, GSE

PARTS DISPOSITION

1. USE
2. REWORK
3. CANNOT BE REWORKED
4. RECORD
5......

S40533

REVISIONS

DISP	EFF	SYM	DESCRIPTION	BY	DATE	CK'D	APPROVAL

CHG LTR

S40533

SHEET INDEX	REV									
	SHEET	1	2	3	4	5	6	7	8	9

	DATE
RELEASE	FEB 4 1965
PREPARED Don Rose	
CHECKED Don Rose	2/3/65
APPROVED	2/4/65
	2-4-65

TITLE

Micrometeorite Ejecta Detector (GSE - Surveyor) ML 260-1, Test Procedure for

MARSHALL LABORATORIES

NO. S40533

SHEET 1 OF 9

ML Form 34

1.0 SCOPE

1.1 This procedure covers the electrical checkout of the GSE after completion of the assembly.

2.0 APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Marshall Laboratories

S40534	Circuit Board Assembly, Digital Readout and Command, (GSE Surveyor), Test Procedure for
S40535	Circuit Board Assembly, Power Supply, (GSE Surveyor), Test Procedure for
S40536	Sensor Stimulus Board, Surveyor Ejecta Detector, Model ML 260-1, Test Specification for

DRAWINGS

Marshall Laboratories

51114	Schematic, Ejecta Detector
51304-101	Assembly, Micrometeorite Ejecta Detector

CHG LTR

S40533

3.0 TEST PROCEDURE

3.1 Make a continuity check of all connector, switches, and point-to-point wiring on the chassis. Refer to Marshall Laboratories Drawing 51114.

3.2 Check all fuses on the rear panel for proper value. Refer to Marshall Laboratories Drawing 51114.

3.3 Remove F104.

3.4 Apply 115V 60 cps A.C. to J9. Depress power switch on front panel.

3.5 Measure 180V from TP GRD to J3-27.

3.6 Set S101A (lamp switch) to LAMPS ON. Check all pushbutton switches on the front panel for proper operation.

3.7 Set S101A switch to LAMPS OFF. All pushbutton switch lights should be out.

3.8 Replace F104.

3.9 For GSE circuit board tests refer to the following specifications:

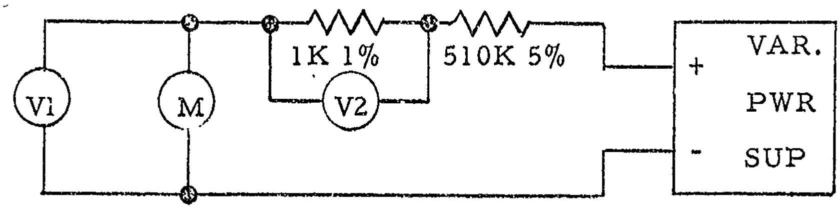
A. S40534 Circuit Board Assembly, Digital Readout and Command, (GSE Surveyor), Test Procedure for

B. S40535 Circuit Board Assembly, Power Supply, (GSE Surveyor), Test Procedure for

C. S40536 Sensor Stimulus Board, Surveyor Ejecta Detector, Model M 260-1, Test Specification for

4.0 METER CIRCUIT CHECKOUT

4.1 <u>Measure Meter Resistance and Record.</u>



RELEASED	FEB 1965	TITLE	
PREPARED		Micrometeorite Ejecta Detector (GSE - Surveyor) ML 260-1, Test Procedure for	MARSHALL LABORATORIES
CHECKED			NO. S40533
APPROVED			SHEET 3 OF

FORM ML 77 MFG. CODE NUMBER 13126

CKG LTR

S40533

4.1 (Continued)

Increase voltage for full scale deflection of panel meter.

Make note of two voltage readings.

Repeat with reversed polarity.

Meter resistance $= \frac{V1}{\frac{V2}{1K}}$ Use average of voltage reading.

4.2 Selection of R19.

R19 = 1580Ω minus meter resistance.

Tack solder in the selected value of R19.

4.3 Selection of R14.

Set decade box across R14. Set for 1K.

Set decade box across J7-R and J7-D (simulated temperature probe). Set to 500Ω.

DO NOT connect panel meter.

Apply power.

Measure across TB5-4 (+) and TB5-1(-) and adjust R110 (28 volt adjust potentiometer on rear of chassis) for 28 volts ±.1V.

Select R14 for 2.50 volt ±.05V across simulated temperature probe.

4.4 30-Volt Reference.

Measure across TB5-6(+) and TB5-1(-) for 30 volts ± 0.1 volts.

Re-select R104, if needed.

RELEASE DATE FEB 1965	DATE	TITLE	
PREPARED		Micrometeorite Ejecta Detector (GSE - Surveyor) ML 260-1, Test Procedure for	MARSHALL LABORATORIES
CHECKED			NO. S40533
APPROVED			SHEET 4 OF

FORM ML 77

MFG. CODE NUMBER 13126

4.5 29 Volt Meter Position.

Disconnect meter leads.

Measure across meter leads and adjust R43 on TB6 for a null.

Connect meter leads. Meter will read zero.

Increase 28 volt with R110 to 29.4 volts (+5%).

Adjust R26 for a full scale positive deflection of meter.

Reduce voltage with R110 for 26.6 volts.

Panel meter should read -5%. Vary 29 volts for a full negative deflection and record.

4.6 3 Volt Meter Position.

Disconnect meter leads.

Apply +3 volts $\pm 0.05V$ to J7-L (+) and ground.

Adjust R47 (TB6) for a null across meter leads.

..connect meter leads. Meter will read zero.

Increase the applied 3 volts to 3.15V (5%).

Adjust R28 for a full positive scale deflection.

Reduce applied voltage for a full scale deflection to the left. Record voltage.

4.7 12 Volt Meter Position.

Disconnect meter leads.

Apply external 12 volts $\pm 0.1V$ to J7-E (+) and ground.

Adjust R41 (TB-6) for a null across meter leads.

Reconnect the meter; meter will read zero.

Increase the applied voltage 5% (+12.60V)

Adjust R30 for a full positive scale deflection.

Decrease applied voltage for a full negative deflection and record voltage.

4.8 6 Volt Meter Position.

Disconnect meter.

Apply +6 volt ±.050 to J7-K (+) and ground.

Adjust R45 (TB6) for a null across meter leads.

Reconnect meter; meter will read zero.

Increase applied voltage 5% to 6.3 volts.

Adjust R32 for a full scale positive deflection.

Decrease the applied voltage for a full negative deflection and record voltage.

4.9 Minus 7 Volt Position.

Disconnect panel meter leads.

Apply -7 volts ±0.1V to J7-F (-) and ground.

Adjust R55 (TB6) for a null across meter leads.

Connect the meter; meter shall read zero.

Increase the applied voltage 5% to -7.35 volts.

Adjust R34 for a full positive scale deflection.

Reduce the applied voltage for a full scale negative deflection and record voltage.

4.10 Heater Current Position.

Disconnect meter leads.

To simulate the heater load, connect a 440-Ω (decade box) load across J7-U (+) and J7-T (-).

Place digital across meter leads and null out with R36.

Depress heat power switch.

Adjust R115 (rear of chassis) for a 22.0 volt ±0.1V across simulated heater load.

4.10 (Continued)

Voltage across meter leads should read 250 mv $\pm$10 mv.

Turn off heater power and connect meter.

With heater power off the meter will read zero and full scale with heater power turned on.

CKG LTR

4.11 Total Current Position.

Disconnect meter.

Simulate load with a decade box set to 1.3K (21.5 ma) and a triplett in series.

Turn on experimental power and null meter lead with R53 (TB6).

Reconnect meter; meter shall read zero.

Decrease decade box to a load of 26.5 ma (approximately 1.06K).

Adjust R22 for a full scale positive deflection.

Increase decade box to a load of 16.5 ma (approximately 1.7K).

Meter should now read a full negative scale deflection.

S40533

4.12 Temperature Position.

Disconnect meter leads.

Simulate temperature sensor with a decade box. Set across J7-R (+) and J7-D (-) set at 470 .

Adjust R49 for a null across the meter leads.

Reconnect meter.

Place decade box to 790 Ω.

Adjust R20 (TB6) for 100°C reading on meter.

Decrease decade box to 230 Ω. °Meter should read -100°C.

RELEASE RELEASED	DATE FEB 1 1965	TITLE	
PREPARED		Micrometeorite Ejecta Detector (GSE - Surveyor) ML 260-1, Test Procedure for	MARSHALL LABORATORIES
CHECKED			NO. S40533
APPROVED			SHEET 7 OF

FORM ML 77

MFG. CODE NUMBER 13126

CHG LTR

S40533

4.13 <u>2 Volt Meter Position.</u>

Disconnect meter.

Apply 2.0V through a 15.7K (decade box) to J1-G (+) and ground.

Adjust R51 (TB6) for a null across meter leads.

Reconnect meter; meter shall read zero.

Increase voltage 5% (2.10 volts) and adjust R24 (TB6) for a full scale positive deflection.

Reduce voltage for a full scale negative deflection and record.

5.0 MIC VERNIER

5.1 Vernier potentiometer R63 is setup as follows: Set dial reading to 5000, select R94 for 5.00V ± 50 mv at the wiper of R63.

6.0 MIC PRESET

6.1 The select resistors located on TB8 are as follows:

R72 = 33K	R67 = 2.7K
R71 = 240	R66 = 5.1K
R70 = 620	R65 = 11K
R69 = 1.0K	R64 = 27K
R68 = 1.6K	

7.0 FILM VERNIER

7.1 Vernier potentiometer R73 is setup as follows: Set dial reading to 5000, select R74 for 5.00V ±50 mv at the wiper of R73.

S40533

8.0 FILM PRESET

8.1 The select resistors located on TB7 are as follows:

R96	=	33K	R83	=	5.6K
R91	=	300	R82	=	9.1K
R90	=	510	R81	=	325
R89	=	750	R80	=	430
R88	=	1.0K	R79	=	620
R87	=	1.5K	R78	=	2.2K
R86	=	2.0K	R77	=	7.5K
R85	=	3.0K	R76	=	16K
R84	=	3.9K	R75	=	∞

PARTS DISPOSITION		S40534
1. USE 2. REWORK	3. CANNOT BE REWORKED 5...... 4. RECORD	

REVISIONS

DISP	EFF	SYM	DESCRIPTION	BY	DATE	CK'D	APPROVAL

CHG LTR

S40534

FEB 2 1965

SHEET INDEX	REV						
	SHEET	1	2	3	4	5	6

RELEASE	DATE	TITLE	MARSHALL LABORATORIES
PREPARED Don Rose/lb	1-7-65	Digital Readout and Commands Board Surveyor Ejecta Detector, ML 260-1 Test Procedure for	
CHECKED N Rose	2-2-65		NO. S40534
APPROVED H Rosenberg	2-2-65		
fr	2/4/65		SHEET 1 OF 6

ML Form 34

1.0 SCOPE

1.0 Scope. This procedure describes the test required to verify proper operation of the electronics on Digital Readout and Commands Board. This assembly 51327-101 is a portion of the Surveyor Ejecta Detector ML 260-1.

CHG LTR

S40534

2.0 APPLICABLE DRAWINGS

Marshall Laboratories

51287 Sheet 1	Schematic
T51311-1-101	Matrix
51327-101	Digital Readout ana Commands Assembly.

3.0 TEST EQUIPMENT

(Equivalent units are acceptable)

3.1 Oscilloscope - Tektronix Type 535A.

3.2 Plug-In Unit - Tektronix Type CA.

3.3 Digital Voltmeter - Non linear Systems Model 481.

3.4 Volt - Ohmeter - Triplett Model 630NA.

3.5 Pulse Generator - Intercontinental Instruments Incorporated, PG-2.

3.6 Power Supply - Harrison Laboratories Model 865B.

4.0 PRELIMINARY TEST

4.1 Make a continuity check from all pins on J4, J5 and P3 to proper modules and tie points.

4.2 Apply 3.0 ± .1v to P3-7 and ground to P3-2.

RELEASE	FEB DATE 1965	TITLE	MARSHALL LABORATORIES
PREPARED		Digital Readout and Commands Board Surveyor Ejecta Detector, ML 260-1 Test Procedure for	NO. S40534
CHECKED			SHEET 2 OF
APPROVED			

5.0 DIGITAL READOUT

5.1 Apply a 100 ± 2 cps square wave .1 ± .1v to 1.5 ± .1v to P3-21. Syncronize the scope on the positive going edge.

5.1.1 Observe waveform on Z9-6. Should be the inverse of the square wave in Section 5.1 3.0v ± .1v to .1v ± .1v.

5.1.2 Wave form at Z10-6 should be a positive pulse .1v ± .1v to 2.2v ± .1v, pulse width of 3.0 ms.

5.1.3 Waveform at Z11-6 should be a positive pulse delayed by 3.0 ms ± .3 ms, amplitude .1v ± .1v to 2.2v ± .1v, and pulse width 200 μsec ± 20 μsec.

5.1.4 Connect Z2-6 to Ground. Observe a negative going pulse delayed by 3.0 ms ± .3 ms, amplitude 3.0 ± .1v to .1v ± .1v on Z12-6.

5.1.5 Waveform at Z13-6 should be a negative pulse 3.0v ± .1v to .1v ± .1v, delayed by 3.0 ms ± .3 ms, pulse width 30 μsec ± 5 μsec.

5.1.6 Syncronize scope on Z19-6, negative edge. Observe waveform at Z14-5. It should be a square wave starting at .1v ± .1v and going to 2.2v ± .1 at 10.0 ms delay from sync. Frequency is 50 cps (20 ms). Check Z14-6 wave inverted.

5.1.7 Observe waveform at Z15-5. It should be a square wave starting at .1v ± .1v and going to 2.2v ± .1 at 20 ms delay from sync. Frequency is 25 cps (40 ms). Check Z15-6 wave is inverted.

5.1.8 Observe waveform at Z16-5. It should be a square wave starting at .1v ± .1v and going to 2.2v ± .1 at 40 ms delay from sync. Frequency is 12.5 cps (80 ms). Check Z16-6 wave is inverted.

5.1.9 Observe waveform at Z17-5. It should be a square wave starting at .1v ± .1v and going to 2.2v ± .1 at 80 ms delay from sync. Frequency is 6.25 cps (160 ms). Check Z17-6 wave is inverted.

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5.1.10 Observe waveform at Z17-8. It should be a negative going pulse. Amplitude is 3.0v ± .1 to .1v ± .1v. Pulse width is approximately 20 μsec.

5.1.11 Remove Ground that was connected in Section 5.1.4 and the pulse in section 5.1.10 should disappear. Connect P3-35 to 3.0v.

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5.1.12 Replace the Ground to Z2-6. Observe waveform at Z7-6. It should be a positive going pulse, .1v ± .1v to 2.2v ± .1v. Pulse width is 400 μsec ± 40 μsec. Also Z41-5 should be at .1v ± .1v.

5.1.13 Reset generator described in Section 5.1 to 1 cps.

5.1.14 Observe Z3-5, Z4-5, Z5-5, they should be at 2.2v ± .1v.

5.1.15 Remove P3-35 from 3.0v and connect it to Ground.

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5.1.16 Observe Z3-5, Z4-5, Z5-5, they should be at .1v ± .1v.

5.1.17 Place scope on Z12-6. Within one second after the removal of the wire on P3-35, a negative pulse will appear. A total of sixteen pulses, one second apart will appear. After which, the output at Z12-6 will return to 3.0v and hold.

5.1.18 Connect Z2-6 to ground. Connect μ3-35 to +3.0v.

5.1.19 Observe Pin 5 of each of the following modules. Z8, 20, 21, 22, 23, 24, 25, 25, 27, 28, 29, 30, 31, 32, 33, and 34.

5.1.19.1 The output at Pin 5 of the modules should be 2.2v ± .1.

5.1.20 Remove P3-35 from 3.0v and connect it to ground.

5.1.21 Repeat Section 5.1.19.

5.1.21.1 The output at Pin 5 of the modules should be .1v ± .1v.

5.1.22 Remove all connections except +3v and ground.

5.2 Command Signals.

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5.2.1 Apply +29v ± .5v P3-8.

5.2.2 Apply negative going pulse to P3-11. Amplitude 3.0v, pulse width 100 μsec, at 1 cps.

5.2.3 Observe positive pulse at Z38-6, .1v ± .1v to 2.2v ± .1, pulse width 700 μsec ± 100 μsec.

5.2.4 Observe positive pulse at Z37-6, .1v ± .1v to 2.2v ± .1, pulse width 20 μsec ± .2 μsec.

5.2.5 Observe positive pulse at Z35-6, the amplitude should be 0v to 29v ± .2v, pulse width 20 μsec ± .2 μsec. Observe pulse at the junction of R_1 and R_2. The amplitude should be 23v ± 1v. Risetime 2msec ± .5msec.

5.2.6 Connect Ground to P3-9 and then to P3-10. The pulse in Section 5.2.5 should disappear.

5.2.7 Remove Ground from P3-9 and P3-10.

5.2.8 Observe pulse at Z36-6. It should be the same as in Section 5.2.5. The pulse at the junction of R4 and R3 should have an amplitude of 23v ± 1v and a rise time of 2msec ± .5msec.

5.2.9 Connect Ground to P3-10 and P3-12, the pulse in Section 5.2.3 should disappear.

5.2.10 Remove Ground from P3-10 and P3-12.

5.2.11 Observe pulse at Z39-6. It should be the same as in Section 5.2.5. The pulse at the junction of R6 and R5 should have an amplitude of 23v ± .5v, and a rise time of 2msec ± .5msec.

5.2.12 Connect Ground to P3-10 and P3-13, the pulse should disappear.

5.3 Commands (Enter Data)

5.3.1 Connect Ground to P3-10.

5.3.2 Observe the output at Z44-18, It should be a square wave 1.0 ± .5 cps amplitude 3.0v ± .1 to .1v ± .1v.

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5.3.3 Observe the output at Z43-6, It should be the inverted signal of Z44-18. Amplitude 3.0v ± .1v to .1v ± .1.

5.3.4 Observe the output at Z42-6. It should be at one half the frequency of Z43-6, amplitude 2.2v ± .1v to .1v ± .1.

5.3.5 Observe the output at Z40-6. It should be a positive pulse 200 μsec wide at a repetition rate of one half Z44-18. Amplitude .1v ± .1v to 2.2v ± .1v.

5.3.6 Observe pulse at Z19-6. It should be a negative going pulse 3.0v ± .1v to .1v ± .1 and approximately 20 μsec wide and at the same rate as described in Section 5.3.5.

5.3.7 Monitor Z41-5. If not at .1v ± .1v, momentarily ground Pin 5. The output should return to 2.2v ± .1 on the leading edge of Z40-6.

5.3.8 Monitor Z40-6.

5.3.8.1 Connect P3-15 to Ground. The pulses in Section 5.3.8 should disappear.

5.3.9 Remove Ground from P3-10.

5.3.10 Observe Z42-6. If it is not at .1v ± .1v, momentarily ground pin 6 of Z42.

5.3.11 Momentarily Ground P3-17 and Z42-6 should return to 2.2v ± .1v.

5.3.12 Momentarily connect P3-16 to 3.0v and Z42-6 should return to .1v ± .1v.

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PARTS DISPOSITION		S40535
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REVISIONS

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	DATE	TITLE	
RELEASE	~~FEB 4 1965~~	Power Supply Board, GSE - Surveyor Test Specification for	MARSHALL LABORATORIES
PREPARED B. Wunegar			NO. S 40535
CHECKED R.C. [illegible]	Feb 1 65		
APPROVED R. Carawin [illegible]	FEB 65 2-4-65		
[illegible]	2-4-65		SHEET 1 OF 5

ML Form 54

S 40535

1.0 SCOPE

1.1 This procedure describes the tests required to verify the proper operation of the power supply board (Assem. 51328) this is part of the Surveyor's ground support equipment.

2.0 APPLICABLE DRAWINGS

2.1 Board Assembly, Power Supply GSE, 51328

2.2 Schematic diagram, micrometeorite ejecta detector, GSE Surveyor 51287.

2.3 Mylar Matrix, 51305-101.

3.0 TEST EQUIPMENT

3.1 Oscilloscope, Tektronix, Model 535A.

3.2 Plug-in pre-amp., Type CA.

3.3 Power Supply, Harrison Laboratory, Model 865B.

3.4 Resistor Decade Box, General Radio, Type K132L.

3.5 Digital Voltmeter, Cubic model, V-71.

3.6 Transistors, 2N1485, 3 ea.

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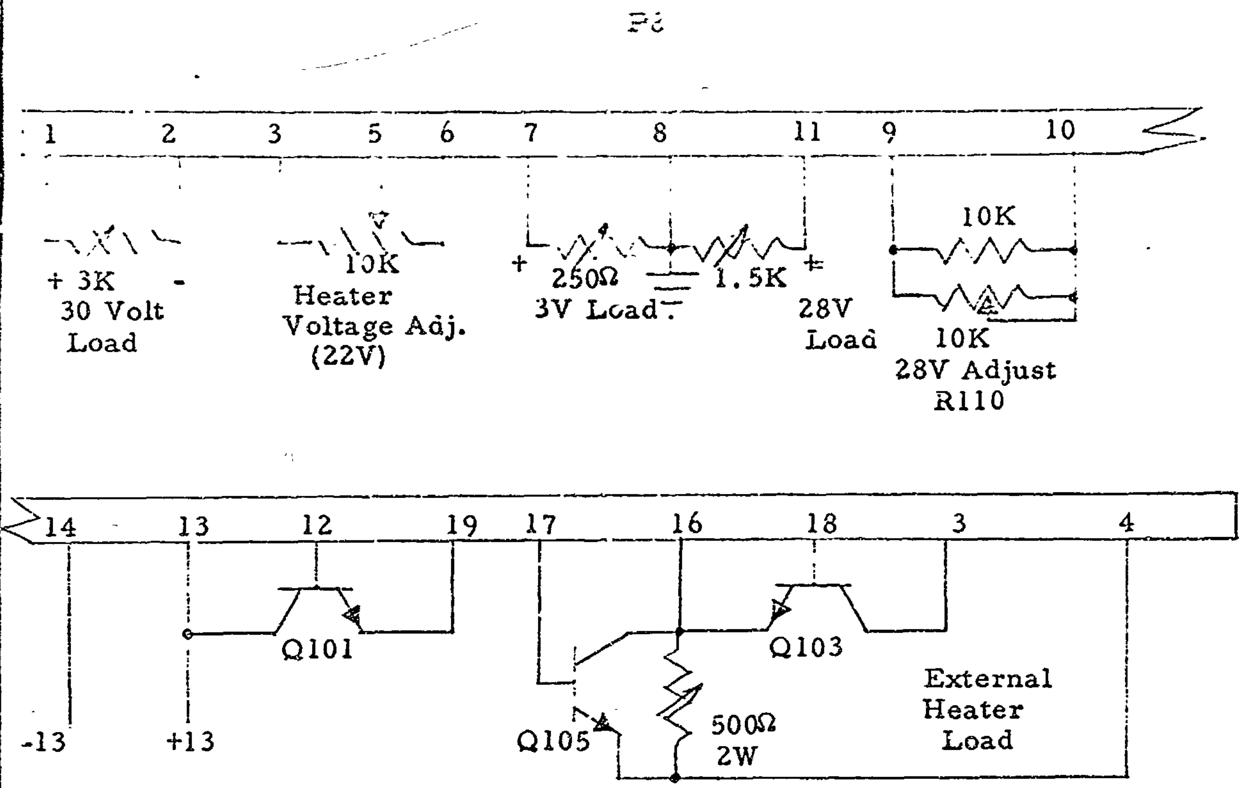

Figure 1.

4.0 TEST PROCEDURE

4.1 Check continuity from P8 connector to board as per print 51287.

4.2 Temporarily install nominal values for R103, R104, and R114.

4.3 Make test hook up as in Figure 1.

4.4 Limit input current to 400 ma ± 25 ma.

4.5 Apply 13.3 volts ± 0.13v to P8 - 13 (+) and P8 - 14 (-).

4.6 Select R102 for 11.0 volts ± 0.1v at Z101-17 (+) and Z101-2 (-).

4.7 Select R103's value for a 2400 cps ± 100 cps square wave and an amplitude of 22 volts ± .5v at the converter transformer SP 30279 Pin 1 and 13.3 volt return.

4.8 Adjust the external loads.

3 volts at 10 ma

22 volts at 50 ma

28 volts at 20 ma

30 volts at 10 ma

4.9 28 Volts Supply

4.9.1 Adjust R110 to Mid position

4.9.2 Select R114 for 28 volts ± .25v, maintain a 22 ma load.

4.9.3 Check range of R110 from min. 26.5 + 0.0v - .3v to max. 28.5 volts + .3v - 0.0v. Select R114 for this range of R110.

4.9.4 Tack solder R114 in place and record value.

4.9.5 Maintain a 20 ma load on the 28 volt line for balance of test.

4.10 3 volt supply

4.10.1 Measure voltage at P8 - 7 and ground with a 10 ma load. This should be 3.0 volts ± 5%.

4.10.2 Remove external load. The voltage will still be 3.0 volts ± 5%.

4.10.3 Reconnect 10 ma load for balance of test.

4.11 Heater voltage (22 volts)

4.11.1 Adjust R115 for 22 volts ± 0.1v across P8 - 16 (+) and P8-4 (-) with an external load of 50 ma.

4.11.2 Maintaining a 50 ma load, vary R110 from min. of 16.5 ± 200 mv to a maximum of 26.5 ± 200 mv.

4.11.3 Return to 22 volts at 50 ma for balance of test.

4.11.4 Insert an am-meter in series of emitter of Q105. This should read not more than 10 ma.

4.11.5 Caution: Set meter to 60 ma scale. Remove external load, emitter current will jump to 50 ma ± 1%. If needed, reselect R112 for proper emitter current.

4.11.6 Reconnect 50 ma external load. Restore emitter circuit.

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4.12 30 volt supply.

4.12.1 Select R104 for 30 volts ± .1v as read across P8-1 (+) and P8-2 (-) with a 10 ma load.

4.12.2 Tack solder R104 in place and record.

4.12.3 Vary load from 8 ma to 12 ma. Voltage regulation shall be 30 volts ± .1v.

4.12.4 Return load to 10 ma for balance of test.

4.13 Total Current

4.13.1 Vary input to power supply board from 12.0 volts to 14.6 volts. The voltage across Z101-17 + and Z101-2 shall remain at 11.0 volts ± .1v.

4.13.2 Record total input current at 12.0 volts and at 14.6 volts.

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PARTS DISPOSITION		
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RELEASE: Released	DATE: 10/29/64	TITLE: Sensor Stimulus Board Surveyor Ejecta Detector ML 260-1 Test Specification For
PREPARED: D. Rose/go	10/29/64	
CHECKED: Don Rose / Bromber	11/17/64	
APPROVED: H. Lamb	11/17/64	

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ML Form 34

1.0 SCOPE

This procedure describes the test required to verify proper operation of the electronics on the Sensor Stimulus Board. This Assembly 51326 is a portion of the Surveyor Ejecta Detector ML 260-1.

2.0 APPLICABLE DRAWINGS

2.1 51326 Assembly, Sensor Stimulus

2.2 51287 Sht. 3 Schematic

2.3 51324-101 Matrix

3.0 TEST EQUIPMENT

3.1 The following standard test equipment, or equivalent, shall be used to check out the module.

3.1.1 Oscilloscope - Tektronix, Model 535A.

3.1.2 Plug-In Unit - Tektronix, Type CA.

3.1.3 Digital Voltmeter, Non-Linear Systems, Model 481.

3.1.4 Volt-Ohmmeter, Triplett Model 630NA.

3.1.5 Pulse Generator - Intercontinental Instruments Incorporated, PG-2.

3.1.6 Power Supply - Harrison Laboratories, Model 865B.

4.0 PRELIMINARY TEST

4.1 Make a continuity check from all pins on P6 to proper module pins.

4.2 Apply 3.0v to J6-13 and ground to J6-41.

5.0 STIMULUS TIMING

5.1 Apply a 1.5v negative going pulse, 100µsec pulse width and 5 cps repetition rate to J6-19.

NOTE: All amplitude and timing measurements should be within ± 20% unless otherwise specified.

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5.1.1 The output at Z45-6 should be a 2.2v ± .1v positive pulse 50μsec wide.

5.1.2 The output at Z46-6 should be a 2.2v ± .1v positive pulse 450μsec wide.

5.1.3 The output at Z47-6 should be a 2.2v ± .1v positive pulse 45 msec wide.

5.1.4 The output at Z48-6 should be a 2.2v ± .1v positive pulse 20 μsec wide.

5.1.5 The output at Z49-8, Z50-8, and Z51-8 should be a 2.8v ± .1v negative going pulse 20 μsec wide.

5.2 Connect the following wires to gnd.: P6-3, 6, 30, 40.

5.2.1 The output at Z58-6 should be positive pulse 2.2v ± .1v delayed from the leading edge of the pulse described in Section 5.1 by less than 5 μsec, and a pulse width of 200 μsec.

5.2.2 Disconnect gnd. from P6-3, and observe pulse as described in Section 5.2.1.

5.2.3 Disconnect gnd. from P6-6, and observe pulse as described in Section 5.2.2. In addition a pulse should appear delayed by 500 μsec ± 50 μsec.

5.2.4 Disconnect gnd. from P6-30, and observe pulse as described in Section 5.2.3. In addition a pulse should appear delayed by 50 ms ± 5 ms.

5.3 Connect the following to gnd.: P6-8, 7, 1, 25.

5.3.1 The output at Z66-6 should be positive pulse 2.2v ± .1v delayed from the leading edge of the pulse described in Section 5.1 by less than 5 μsec., and a pulse width of 5 ms ± .5 ms.

5.3.2 Disconnect gnd. from P6-8, and observe pulse as described in Section 5.3.1.

5.3.3 Disconnect gnd. from P6-7, and observe pulse as described in Section 5.3.2.

5.3.4 Disconnect gnd. from P6-1, and observe pulse as described in Section 5.3.3. In addition a pulse should appear delayed by 50 m sec. ± 5 msec.

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5.4 Connect the following to gnd. P6-9, 29, 2.

5.4.1 The output at Z71-6 should be a positive pulse 2.2v ±.1v delayed from the leading edge of the pulse described in Section 5.1 by less than 5 µsec., and a pulse width of 5 msec ± .5 msec.

5.4.2 Disconnect gnd. from P6-9 and observe pulse as described in section 5.4.1.

5.4.3 Disconnect gnd. from P6-29, and observe pulse as described in section 5.4.2.

5.4.4 Disconnect gnd. from P6-2, and observe pulse as described in section 5.4.3.

5.5 Remove all wires that have not been removed previously, except B+ and B+ return.

5.6 Place scope across P6-15 and 16, scope return on P6-16.

5.6.1 Apply 3v to P6-14, and gnd. to P6-25.

5.6.2 Apply a positive pulse 1.5v, 10 µsec., pulse width, and 5 cps repetition rate to pins P6-20, 4, 5, 23 one at a time while observing a pulse on the scope.

5.6.3 The signal as seen on scope should be negative going 0.1 to -3.0v, pulse width ≈ 400 µsec with ≈ 100 µsec rise time. The fall time < 2.0 µsec.

5.6.4 Connect P6-18 to gnd. The signal in section 5.6.2 should disappear.

5.7 Repeat section 5.5

5.8 Place scope across P6-17 and 34, scope return on P6-34.

5.8.1 Apply 3v to P6-28.

5.8.2 Apply pulse as in section 5.6.2 except to pins P6-20, 4, 24, 25.

5.8.3 The signal should be ≈ 2.0 Msec., 0.1 to -3.0v, ≈ 1 ms rise time. Fall time should be < 2.0 µsec.

5.8.4 Connect P6-18 to gnd. The signal in section 5.8.3 should disappear.

5.8.5 Remove connection made in section 5.8.4. The signal should again disappear when grounding P6-33.

5.9 Remove gnd on P6-33. Replace scope on P6-27 and 34 scope return on P6-34.

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5.9.1 The signal should be as in section 5.8.3.

5.9.2 Connect P6-18 to gnd. The signal in section 5.9.1 should disappear.

5.9.3 Remove connection made in section 5.9.2. The signal should again disappear when grounding P6-32.

6.0 Remove gnd. on P6-32. Replace scope on P6-39 and 22 scope return on P6-22.

6.1 Repeat section 5.8.2, through section 5.8.5.

6.2 Remove gnd on P6-33. Replace scope on P6-21 and 22 scope return on P6-22.

6.2.1 The signal should be as in section 5.8.3.

6.2.2 Connect P6-18 to gnd. The signal in section 6.2.1 should disappear.

6.2.3 Remove gnd on P6-18. The signal should disappear when grounding P6-32.

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PARTS DISPOSITION		
1. USE 2. REWORK	3. CANNOT BE REWORKED 4. RECORD	5.......

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REVISIONS

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PREPARED H. Rosenberg/gp	9/14/64	
CHECKED Nion Kose	9/26/64	
APPROVED H Rosenberg	9/30/64	
	9/30/64	

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ML Form 3?

9/30/64

1.0 SCOPE

1.1 This procedure describes the tests required to verify proper operation of the electronics in the Surveyor Power Supply Blivet. This assembly, 51122, is a portion of the Surveyor Micrometeorite Electa Detector, ML 185-1.

2.0 APPLICABLE DRAWINGS

2.1 Marshall Laboratories 51122 Housing Assembly, Power Supply

2.2 Marshall Laboratories 51114 Schematic

2.3 Matrix Mylars - T51210-1, T51215-1, -2.

3.0 TEST EQUIPMENT (Equivalent units are acceptable).

3.1 Oscilloscope - Tektronix, Type 535A.

3.2 Plug-In Unit, Tektronix, Type CA.

3.3 Digital Voltmeter, Non-Linear Systems, Model 481.

3.4 Volt-Ohmmeter, Triplett, Model 630NA.

3.5 True RMS Voltmeter - Ballantine Model 320.

3.6 Pulse Generator, Marshall Laboratories Model 246-1.

3.7 Power Supply, Harrison Laboratories, Model 865B.

4.0 PRELIMINARY TESTS

4.1 Perform visual inspection on parts and welds.

4.2 Using Triplett Volt-ohmmeter on 1K scale, check continuity of pins of connectors 252J02 and J3 to proper terminations.

5.0 POWER SUPPLY

5.1 Install the nominal value of resistors R1 (27K 1/4w 5%), R2 (EM 1/10 4.99K 1%), and R3 (EM 1/10 4.99K 1%).

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5.2 Connect resistors from J3 to ground according to Table I.

Voltage	Pin Location	Resistor
+12v	J3-16	2.0K
+ 6v	J3-36	1.6K
+ 3v	J3-19	330 Ω
- 7v	J3-11	560 Ω

TABLE I. Power Supply Loads

5.3 Apply +28v to J2-1 and +28v return to J2-2.

5.4 The waveform at Z81-10 should be a 0 ± .1v to 56 ± 2.0v, square wave. Select R1 so that frequency is 2400 ± 200 cps.

5.5 The voltage at Z79-1 should be +6.00 ± .10v measured with a differential voltmeter.

5.5.1 The ripple on the +6v line should be less than 2.5 mv rms measured on the Ballantine RMS Voltmeter.

5.6 The voltage at Z79-10 should be +3.00 ± .06v measured with a differential voltmeter.

5.6.1 The ripple on the +3v line should be less than 15 mv RMS measured on the Ballantine RMS voltmeter.

5.7 Select the value of R2 so that the voltage at Z82-1 is +12.00 ± .10v.

5.7.1 The ripple on the +12v line should be less than 1.5 mv RMS measured on the Ballantine RMS voltmeter.

5.8 Select the value of R3 so that the voltage at Z83-1 is -7.00 ± .070v.

5.8.1 The ripple on the -7v line should be less than 1.5 mv RMS measured on the Ballantine RMS voltmeter.

5.9 B Supply Monitor

5.9.1 The voltage at J2-25 should be +2.04 ± .041v.

6.0 TELEMETRY AND READOUT

6.1 Select values.

6.1.1 Select C7 and C9 (2000 pf NOM), which attach to Z24-3, 9 and Z24-10, 17 so that the clock output at Z24-18 is 100 ± 1 cps. The amplitude of this square wave should be .1v ± .1v to 2.9v ± .1v.

6.2 The output of Z21, pin 6, should be a positive going pulse 100 ± 2μs wide, .1 ± .1v to 2.2 ± .1v occurring every 10 ± 0.1 ms.

6.2.1 A negative pulse should also be observed at Z18-12, the amplitude should be 0.1 ± 0.1v to +3.0 ± 0.1v.

6.3 Apply a +3v to 0v negative pulse at a 1 cps rate to J3-14. The pulse at Z18-12 (6.2.1) should no longer appear. This pulse should now appear at Z19-6. Note. Applied pulse has a pulse width of 100 μsec.

6.4 Sequence.

6.4.1 The output of Z16, pins 3 and 5, should be a 50 cps (period = 20 ms) square wave whose amplitude varies from +2.1 ± 0.1v to 0.1 ± 0.1v for a duration of 190 ms.

6.4.2 The output of Z15, pins 3 and 5, should be a 25 cps (period = 40 ms) square wave whose amplitude varies from +2.1 ± 0.1v to 0.1 ± 0.1v for 190 ms.

6.4.3 The output of Z12, pins 3 and 5, should be a 12.5 cps (period = 80 ms) square wave whose amplitude varies from +2.1 ± 0.1v to 0.1 ± 0.1v for 190 ms.

6.4.4 The output of Z13, pins 3 and 5, should be a 6.25 cps (period = 160 ms) square wave whose amplitude varies from +2.1 ± 0.1v to 0.1 ± 0.1v.

6.4.5 The output of Z14, pins 3 and 5, should be a 3.125 cps (period = 320 ms) square wave whose amplitude varies from +2.1 ± 0.1v to 0.1 ± 0.1v for 190 ms.

6.5 Sync the scope on the negative going edge being applied to J3-14. Load J3-1 with a resistor and capacitor in series to ground. The resistor should be 5K and the capacitor should be 2000 pf. The output pulse at J3-1 should be delayed no more than .6 μs . The output itself should be a negative going +3.0 ± 0.1v to 0.1 ± 0.1v, 10 μs +10 μs, and -0 μsec. pulse occurring at a 1 cps rate.

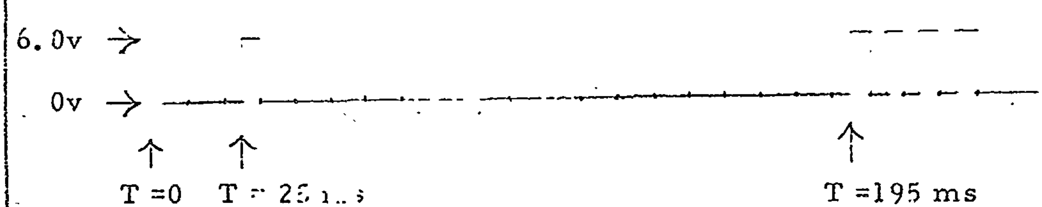
6.6 Readout.

6.6.1 Sync the scope positively on Z16 pin 5.

6.6.2 Connect scope to Z 1 - 11.

6.6.3 Information Output.

6.6.3.1 The output at Z1-11 should be at 0v for 25 ms and rise to 6.0v for 5 ms and return to 0v until T = 195 ms, at that time the output will be a 100 cycle square wave until the next readout pulse.



6.6.3.2 Connect J3-9 to ground. The output at Z1-11 should have a 5 ms pulse at T = 35 ms in addition to that described in 6.6.3.1.

6.6.3.3 Remove ground from J3-9 and connect it to J3-22. The output at Z1-11 should have a 5 ms pulse at T = 45 ms in addition to that described in 6.6.3.1.

6.6.3.4 Remove ground from J3-22 and connect it to J3-2. The output at Z1-11 should have a 5 ms pulse at T = 55 ms in addition to that described in 6.6.3.1.

6.6.3.5 Remove ground from J3-2 and connect it to J3-25. The output at Z1-11 should have a 5 ms pulse at T = 65 ms in addition to that described in 6.6.3.1.

6.6.3.6 Remove ground from J3-25 and connect it to J3-6. The output at Z1-11 should have a 5 ms pulse at T = 75 ms in addition to that described in 6.6.3.1.

6.6.3.7 Remove ground from J3-6 and connect it to J3-21. The output at Z1-11 should have a 5 ms pulse at T = 85 ms in addition to that described in 6.6.3.1.

6.6.3.8 Remove ground from J3-21 and connect it to J3-20. The output at Z1-11 should have a 5 ms pulse at T = 95 ms in addition to that described in 6.6.3.1.

6.6.3.9 Remove ground from J3-20 and connect it to J3-23. The output at Z1-11 should have a 5 ms pulse at T = 105 ms in addition to that described in 6.6.3.1.

6.6.4.0 Remove ground from J3-23 and connect it to J3-3. The output at Z1-11 should have a 5 ms pulse at T = 115 ms in addition to that described in 6.6.3.1.

6.6.4.1 Remove ground from J3-3 and connect it to J3-24. The output at Z1-11 should have a 5 ms pulse at T = 125 ms in addition to that described in 6.6.3.1.

6.6.4.2 Remove ground from J3-24 and connect it to J3-5. The output at Z1-11 should have a 5 ms pulse at T = 135 ms in addition to that described in 6.6.3.1.

6.6.4.3 Remove ground from J3-5 and connect it to J3-32. The output at Z1-11 should have a 5 ms pulse at T = 145 ms in addition to that described in 6.6.3.1.

6.6.4.4 Remove ground from J3-32 and connect it to J3-26. The output at Z1-11 should have a 5 ms pulse at T = 155 ms in addition to that described in 6.6.3.1.

6.6.4.5 Remove ground from J3-26 and connect it to J3-4. The output at Z1-11 should have a 5 ms pulse at T = 165 ms in addition to that described in 6.6.3.1.

6.6.4.6 Remove ground from J3-4 and connect it to J3-8. The output at Z1-11 should have a 5 ms pulse at T = 175 ms in addition to that described in 6.6.3.1.

6.6.4.7 Remove ground from J3-8 and connect it to J3-7. The output at Z1-11 should have a 5 ms pulse at T = 185 ms in addition to that described in 6.6.3.1.

6.6.4.8 Remove ground from J3-7.

6.6.5 SCO Driver

6.6.5.1 The output at J2-13 should be a 0v for 25 ms, rise to +6.0v for 5 ms, fall to 0v for 165 ms, and then return to a +3.0v 100 cps square wave. The rise and fall time should be ≈ 400 μsec.

6.6.6 Mic Accumulator Inhibit

6.6.6.1 The output at J3-33 should be at +3.0v for the first 120 ms of the readout, fall to 0v for 30 ms, and then return to +3.0v.

6.6.7 Film Accumulator Inhibit

6.6.7.1 The output at J3-30 should be at +3.0v for the first 150 ms of the readout, fall to 0v for 40 ms, and then return to +3.0v.

6.6.8 Detect End of Readout

6.6.8.1 The output at J3-27 should be at +3.0v for the whole readout of 200 ms. At 200 ms, a negative going pulse 100 ms wide every 10 ms should appear at J3-27.

7.0 COMMANDS

7.1 Calibrate Command

7.1.1 Apply to J2-10 a positive going 20 ms 0 to 15v pulse with a 2ms rise time and a .1 ms fall time. At j3-31 the output pulse should be a negative going pulse 2.3v ± .1 to .1v ± .1v, pulse width of 20 ms ± 2 ms.

7.2 Clear Command

7.2.1 Apply to J2-11 a positive going 20 ms, 0 to 15v pulse with a 2 ms rise time and a .1 ms fall time. The output at J3-28 should be a positive going pulse, from 0.1v, ± 0.1v to 2.3v ± .1v, and 1.5 ms ± .15 ms in duration.

7.3 Readout Command

7.3.1 Apply to J2-22 a positive going, 20 ms, 0 to +15v pulse with a 2 ms rise time and a .1 ms fall time.

7.3.2 The output at Z23-11 should be a negative pulse, 2.3v ± .1v in amplitude and 20 ms ± 2 ms duration.

7.3.3 The output at Z1-11 should be as described in 6.6.3.1.

CKS LTR

S40519

RELEASE	DATE	TITLE	
Released	9/16/64	Surveyor Power Supply Blivet Test Specification For	MARSHALL LABORATORIES
PREPARED H. Rosenberg/go	9/16/64		
CHECKED			NO. S40519
APPROVED			SHEET 8 OF 8

PARTS DISPOSITION

1. USE
2. REWORK
3. CANNOT BE REWORKED
4. RECORD
5......

S40548

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S40548

REVISIONS

DISP	EFF	SYM	DESCRIPTION	BY	DATE	CK'D	APPROVAL

SHEET INDEX	REV											
	SHEET	1	2	3	4	5	6	7	8	9	10	11

RELEASE Released	DATE 10/6/64	TITLE Test Specification for Surveyor Digital Blivet	MARSHALL LABORATORIES
PREPARED			NO. S40548
CHECKED D. Ross RCa...	10-21-64		
APPROVED N Rosenberg	10-21-64		
[illegible]	10-21-64		SHEET 1 OF 11

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S40548 | CHG LTR

1.0 SCOPE

This procedure describes the tests required to verify proper operation of the electronics in the Surveyor Digital Blivet. This assembly, 51237, is a portion of the Surveyor Micrometeorite, Ejecta Detector, ML 185-1.

2.0 APPLICABLE DRAWINGS

2.1 Marshall Laboratories 51237 Housing Assembly, Digital Blivet.

2.2 Marshall Laboratories 51114 Schematic.

2.3 Matrix Mylars TS 1212, TS 1213

3.0 TEST EQUIPMENT

3.1 Oscilloscope, Tektronix Type 535A

3.2 Plug-In Unit, Tektronix, Type CA.

3.3 Digital Voltmeter, Non-Linear Systems, Model 481.

3.4 Volt. Ohmmeter, Triplett, Model 630-NA.

3.5 True R. M. S. Voltmeter, Ballantine Model 320.

3.6 Pulse Generator, Intercontinental Instruments Incorporated, PG-2

3.7 Power Supply, Harrison Lab., Model 865B.

4.0 PRELIMINARY PROCEDURE

4.1 Using a Triplett Ohmmeter, check the resistances between the pins A & B in Table I, use 1K scale, positive lead on A.

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Resistance Between			Resistance Should Be		
A	B	(Ω)			
P3-16	P3-11	>50K	P3-36	J1-5	0
P3-16	P3-36	>10K	P3-19	J1-8	0
P3-16	P3-19	>10K			
P3-11	P3-36	>10K			
P3-19	P3-11	>9K			
P3-36	P3-19	>8K			
P3-13	J1-7	-0-			
P3-16	J1-13	-0-			
P3-11	J1-15	-0-			

4.2 Record all final select components in Laboratory Notebook.
4.3 Refer to Sec. 2.2 for types and tolerances of all select components.

5.0 MIC PULSE HEIGHT ANALYZER

5.1 Select Values

5.1.1 Install the following resistors and capacitors from Table II(a).

R or C	Value
R7	1.00K
R8	4.99K
C35	360 pf
C22	1000 pf
C23	1000 pf
R11	1.0K
R13	1.0K

TABLE II(a) - Select Values in the Mic PHA.

5.1.2 Power

5.1.2.1 Connect +12.00 ± .1V to P3-16.

5.1.2.2 Connect + 6.00 ± .06V to P3-36.

5.1.2.3 Connect + 3.0 ± .03V to P3-19.

5.1.2.4 Connect - 7.0 ± .07 V to P3-11.

5.1.2.5 Connect the commons of the above supplies together and to P3-13.

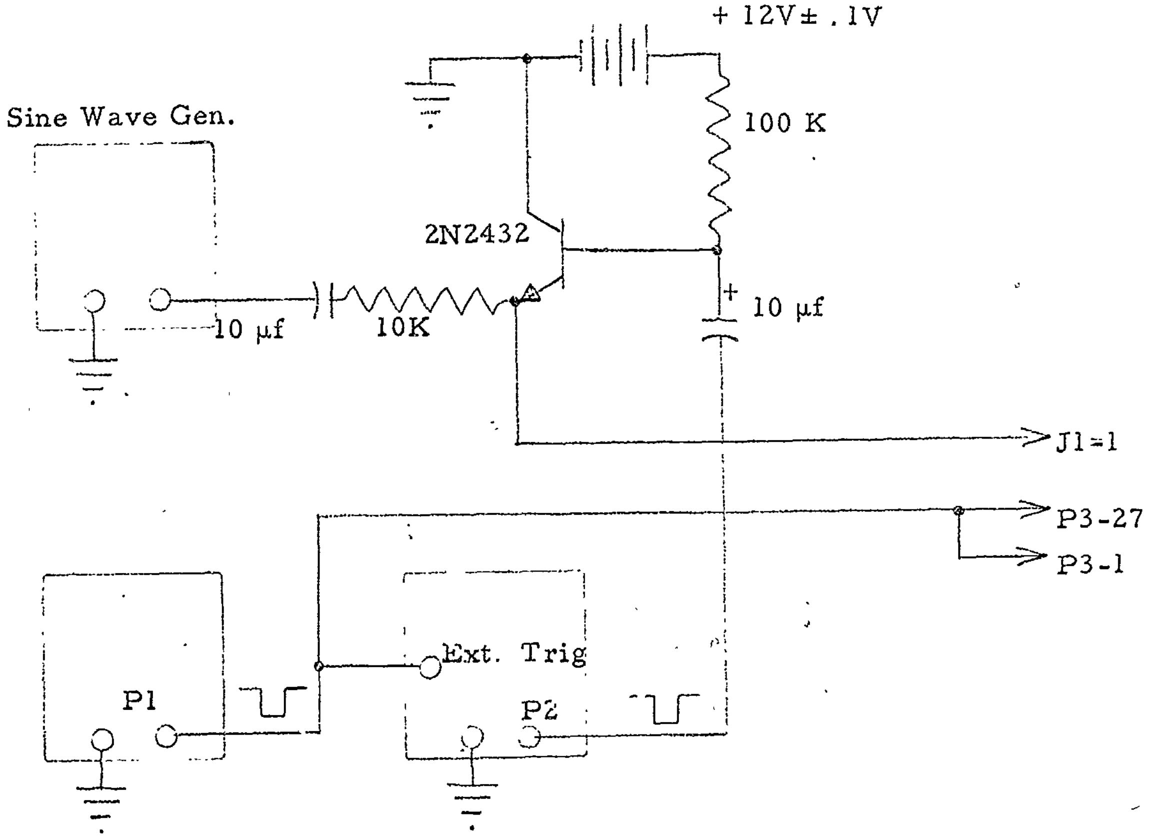

FIGURE 1.

5.2 For the checkout and calibration of the Mic PHA, two Rutherford Pulse Generators are used in conjunction with a sine wave generator through a gate circuit to provide the Mic Amplifier Simulation, Data Reset Pulse, and detect end of readout pulse. See Figure I for connections.

5.2.1 Set P1 for a negative-going +2.0 to 0V, 1.5ms pulse occurring once every 130 ms.

5.2.2 Set P2 to trigger external on the leading edge of P1. Set pulse delay for 50μ sec, Amplitude 2.0V to 0V negative-going, and pulse width for 1.5ms.

5.3 Apply power making sure that none of the supplies are shorted.

5.4 Make the connections shown in Figure I.

5.4.1 Set up the sine wave generator to a 4.0V p-p, 100KC wave and observe at the emitter of the gate transistor a 2V p-p, 1.5 ms burst of a 100KC sine wave occurring once every 130 ms.

5.4.2 Check to see that the Data Reset pulse (the negative going 1.5 ms. gating pulse) appears at Z26.8, Z27-8, Z28-8, Z51-9, Z53-10, Z32-8, Z34-8, Z35-8, Z36-8, and Z37-8.

5.4.3 A negative going +2.9 ± .1V to .1± .1V 100μs pulse should appear at Z53-8 occurring once every 130 ms.

5.5 Observe Z50-6. Adjust C15 until the output is a 2.2 ± 0.2V to 0.1 ± 0.1V, 100 ± 2μs pulse.

5.5.1 At Z48-16, the output should be as in Figure 2.

5.6 Reduce the amplitude of the 100 KC sine wave to OV. The output at Z52-6 should rise from 0V to + 3.0 ± 0.1V for 100 μs and return to 0V.

5.6.1 Increase the amplitude of the sine wave until the comparator output, Z44-7, remains in the up state for 250 μs. The output of Z51, Z51-3.5, should also rise to + 2 ± 0.2V for 250 μs.

5.6.2 With the input sine wave as in 5.61, the output of Z49, Z49-6, should remain at OV for 100 µs, rise to + 2 ± 0.2V for 30 ms, and return to OV.

5.6.3 A positive going pulse should appear at P3-14 for as long as the delay between P1 and P2.

5.6.4 Modules Z31 through Z29 should be counting the simulated mic hits. Pins 3 and 5 of these modules should vary between 0.1 ± 0.1V and +2.2 ± 0.1V.

5.6.5 Further increase the sine wave amplitude until the comparator output, Z44-7, is in the up-state for 1ms. Pins 3 and 5 of modules Z28 through Z26 should change from + 0.1 ± 0.1V to + 2.2 ± 0.1V.

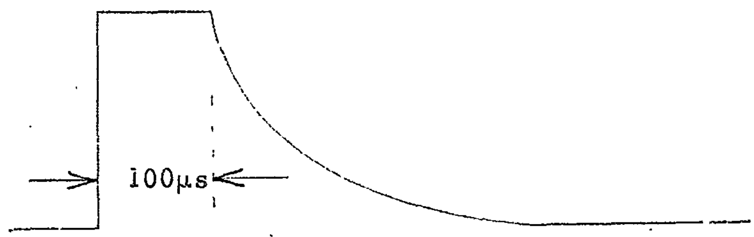

FIGURE 2. Detector Output

5.6.6 Remove signal from P-3 pins 1 and 27. By-pass delay.

5.7 Adjust the 100 kc generator so that the peak amplitude (positive going) at Z48-17 is 100 ± 1 mv.

5.7.1 Select and record the value of R8 which causes the comparator (Z45 and Z44) to change from 0.1 ± 0.1V to 6.0 ± 2V measured at Z44-7.

5.8 Short out pins 4 and 6 of Z51 to ground.

5.9 Adjust C22 and C23 until the frequency of Z42 is as close as possible to 8KC.

5.10 Apply a + 2.5 ± 0.01V peak burst of the 100 KC sine wave to Z48-17. Select and record the value of R7 that just causes seven clock pulse to occur. Where this setup is complete, the τ of the detector output, Z48-16, should be greater than 250 μs and less than 300 μs.

5.10.1 If the value of R7, for any reason, does not satisfy the conditions of 5.8, the clock (Z42) frequency may be varied a minimum amount in order to satisfy 5.9.

5.11 Reduce the amplitude of the sine wave to OV. Slowly increase the sine wave amplitude until the first clock pulse appears at Z42-15. Continue to increase the sine wave amplitude. If the clock pulse disappears and again reappears, the size of C35 should be increased. This process should be repeated until the first false clock pulse does not appear.

5.11.1 Another indication, other than the first clock appearing and disappearing, of a false clock pulse is that it will occur within 100 μs after the comparator has changed state.

6.0 FILM PULSE HEIGHT ANALYZER CALIBRATION

6.1 Select Values.

6.1.1 Install the following nominal value select resistors and capacitors from Table 3.

Part No.	Value
R15, R18	4.99K EM 1/10 1%
R11, R13	1.00K EM 1/10 1%
C20, C21	1000 pf

TABLE 3. SELECT PARTS FOR THE FILM PHA

6.2 For the checkout and calibration of the film PHA, a I.I.I. PG-2 Pulse Generator is used in conjunction with the network shown in Figure 3 to generate the film pulse, the Data Reset Pulse and the detect end of Readout Pulse.

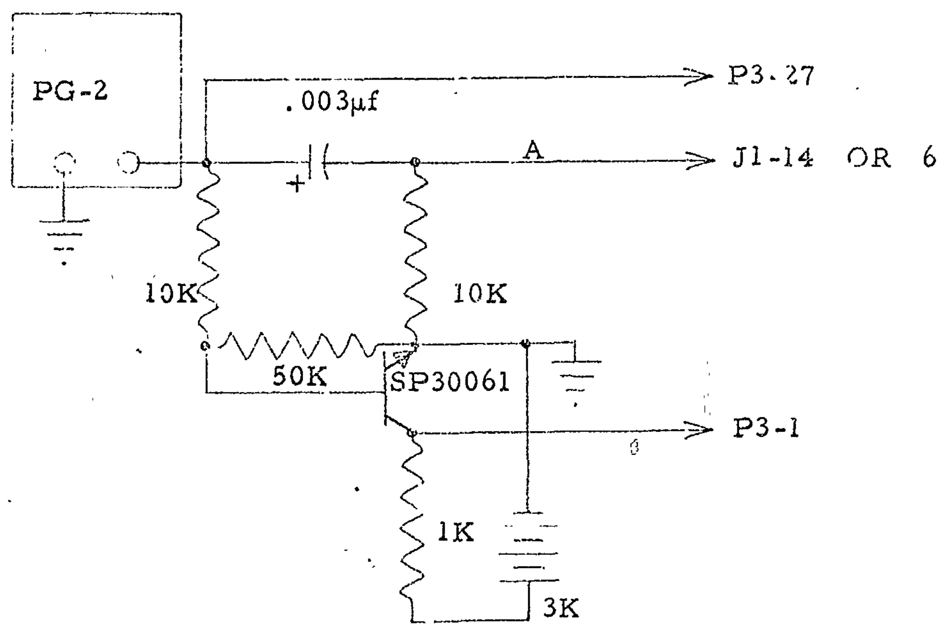

FIGURE 3. Film PHA Test Connectors

6.2.1 Set the pulse generator to put out a positive going 200 ms pulse at a 1 cps rate.

6.2.2 Before connecting the setup to the unit, check that the τ at point A is about 30 μs.

6.3 Apply power to the unit as in 5.1.2

6.4 8 KC Clock

6.4.1 Connect Z63-11 to + 3V.

6.4.2 By adjusting C20 and C21, set the clock frequency to 8000 $\pm$ 80 cps.

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6.4.3 Every 125 μs a positive-going 20 μs pulse should appear at Z85-6.

6.4.4 St Z35 - 3, 5, a 4 KC square wave should appear.

6.4.5 At Z34 - 3, 5, a 2KC square wave should appear.

6.4.6 At Z33 - 3, 5, a 1KC square wave should appear.

6.4.7 At Z32 - 3, 5, a 500 CPS square wave should appear.

6.4.8 Disconnect + 3V from Z63-11.

6.5 Connect the pulse generator setup as shown in Figure 3. connecting point A to J1-14.

6.5.1 Adjust the pulse generator to a nominal output of + 2V.

6.5.1.1 At P3-14, there should be a negative-going + 3V to OV pulse.

6.5.1.2 The voltage at Z65-4 should fall from + 2.2 ± 0.1V to 0.1 ± 0.1V.

6.5.1.3 The voltage at Z36-6 should fall from +2.2 ± 0.1V to 0.1 ± 0.1V. The voltage at Z37-6 should remain at + 2.2 ± 0.1V.

6.5.1.4 The voltage at Z68-6 should fall from + 3.0V to OV.

6.5.1.5 The voltage at Z70-6 should fall from + 3.0V to OV.

6.5.1.6 Modules Z41 through Z38 should be counting the 1CPS pulses from the pulse generator. Pins 3 and 5 of each module should vary between + 0.1 ± 0.1V and + 2.2 ± 0.1V.

6.5.1.7 The voltage at Z84-6 should fall from + 3.0 to OV.

6.5.2 Disconnect point A of Figure 2 from J1-14 and reconnect it to J1-6.

6.5.2.1 Same as 6.5.1.1.

6.5.2.2 The voltage at Z61-4 should fall from +2.2 ± 0.1V to 0.1 ± 0.1V.

6.5.2.3 The voltage at Z37-6 should fall from +2.2 ± 0.1V to 0.1 ± 0.1V. The voltage at Z36-6 should remain at + 2.2 ± 0.1V.

6.5.2.4 The voltage at Z68-6 should fall from + 3.0V to OV.

6.5.2.5 The voltage at Z70-6 should fall from + 3.0V to OV.

6.5.2.6 Modules Z41 through Z38 should be counting the 1CPS pulses from the pulse generator. Pins 3 and 5 of each module should vary between + 0.1 ± 0.1V and + 2.2 ± 0.1V.

6.5.2.7 The voltage at Z84-12 should fall from + 3.0V to OV.

6.6 Threshhold and Calibration.

6.6.1 Remove signals to P-3. Connect point A in Figure 3 to J1-6. Ground Z65-9.

6.6.1.1 Reduce the amplitude of the pulse generator until the peak amplitude at Z69-13 is +50 ± 1 mv.

6.6.1.2 Select the bias resistor, R13, so that one clock pulse appears at Z63-15. Record the value of R13.

6.6.1.3 Adjust the amplitude of the pulse generator such that the peak amplitude at Z69-13 is 1.703 ± 0.17V. Select R18 such that twelve clock pulses occur at Z63-15

6.6.1.3.1 If the proper resistor, R18, is not available, the clock frequency may be adjusted a minimum amount to generate the 12 clock pulses.

6.6.1.4 The τ of the detector output, Z69-16, should be approximately 400 μs.

6.6.2 Disconnect point A from J1-6, connect A to J1-14. Remove ground from Z65-9 and ground Z61-9.

6.6.2.1 Reduce the amplitude of the pulse generator until the peak amplitude at Z58-13 is + 50 ± 1 mv.

6.6.2.2 Select the bias resistor, R-11, so that one clock pulse appears at Z63-15. Record the selected value of R1-1.

6.6.2.3 Increase the amplitude of the pulse generator until the peak amplitude at Z58-13 is + 1.703 ± 0.17V. Select R15 such that twelve clock pulses occur at Z63-15.

6.6.2.3.1 If the proper resistor, R15, is not available, the clock frequency may be adjusted a minimum amount to generate the twelve clock pulses.

6.6.2.4 The τ of the detector output, Z58-16, should be approximately 400 μs.

6.7 Noisy Film Circuit

6.7.1 Set input level to 1.7V. J1-6 and 14. Increase pulse rep rate until the output at Z75-6 goes from 3.0V to OV.

6.7.2 Measure rep rate at Z74-6. It should be $\approx$10 ms.

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APPROVED			

PARTS DISPOSITION			S40660
1. USE 2. REWORK	3. CANNOT BE REWORKED 4. RECORD	5......	

REVISIONS

DISP	EFF	SYM	DESCRIPTION	BY	DATE	CK'D	APPROVAL

CHG LTR

S 40660

SHEET INDEX	REV			
	SHEET	1	2	3

RELEASED FEB	DATE 1965	TITLE	MARSHALL LABORATORIES
PREPARED		Surveyor Sensor Blivet, Test Specification for	
CHECKED D. Rose R.C.C.	2/3/65		NO. S 40660
APPROVED H Rosenberg	2-3-65		
	2/3/65		SHEET 1 OF 3

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S40660

1.0 SCOPE

This procedure describes the test required to verify proper operation of the electronics in the Surveyor Sensor, ML 256-1. This assembly, 51225-101, is a portion of the Surveyor Micrometeorite Ejecta Detector, ML 185-1.

2.0 APPLICABLE DRAWINGS

2.1 Marshall Laboratories, 51254, Assembly-Sensor Electronics

2.2 Marshall Laboratories, 51114, Schematic Diagram, Lunar Ejecta Detector

2.3 Marshall Laboratories, 51225-101, Matrix Assembly

3.0 TEST EQUIPMENT
(Equivalent Units are Acceptable)

3.1 Power Supply, Hewlett-Packard, Model 721A, four required

3.2 Pulse Generator, Rutherford, Model B-15

3.3 Oscilloscope, Tektronix, Type 545-A

3.4 Plug-In Unit, Tektronix, Type CA.

3.5 Resistor Decade, General Radio, Type No. 1432-L.

4.0 TEST PROCEDURE

4.1 Using the schematic diagram (51114) and the mylars (51225-101) as references, connect +6v ± 0.1v to the terminal brought out on the board for connection to J01 - Pin 4. Similarly, connect - 7v ± 0.1v, + 3v ± 0.1v, + 12v ± 0.2v and common to terms J01-7, -11, -12 and 2 respectively.

4.2 Before applying power, verify continuity between all terminals brought out on the board and their respective points of connection to elements on the board.

4.3 To terminal J01 - Pin 8, apply a negative going pulse 1.5v ± .1v in amplitude, 1 ms ± 0.1 ms pulse width and 20 pps ± 2 pps.

4.4 Sync. the scope externally on the negative going edge of the input pulse.

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4.5 The voltage at Z13 Pin 7, Z12 Pins 3 & 10, Z11 Pins 3 & 10 shall be a positive going pulse 2.8v ± 0.2v in amplitude, 20 pps ± 2 pps and 10 ms ± 2 ms Pulse Width.

4.6 The voltage at Z12 pins 4, 5, & 8, and Z11 Pins 4, 5 & 8, shall be a square wave 2.8v ± 0.2v in amplitude, 10 pps ± 1 pps.

4.7 The voltage at Z12 Pins 7, 9 & 11, and Z11 Pins 7, 9 & 11, shall be the same as in Paragraph 4.6, except inverted.

4.8 Temporarily install R6 = 1K, R10 = 1K, R14 = 5.1K and R11 = 1K, using 1/4 watt 5% resistors. Production Department will install flags for this purpose.

4.9 The voltage at TP8 shall be, alternately, a negative going pulse 20 mv ± 5 mv in amplitude, and negative going pulse 140 mv ± 15 mv in amplitude. The pulse rate shall be 20 pps ± 2 pps.

4.10 The voltage at Z16 pin 6 shall be a negative going pulse 70 mv ± 15 mv in amplitude, 10 pps ± 1 pps.

4.11 The voltage at Z17 Pin 6 shall be a negative going pulse 8 mv ± 2 mv in amplitude, 10 pps ± 1 pps.

4.12 Apply a positive going pulse 2.8 v ± 0.2v in amplitude, a rate of 20 pps ± 2 pps and a 10 ms ± 2 ms pulse width to J1 - Pin 5, (Sync. the scope positive).

4.13 Repeat Paragraphs 4.3 and 4.4

4.14 The voltage at J1 - Pin 1 shall be a positive pulse 1750 mv ± 375 mv in amplitude at a 10 pps ± 1 pps rate.

4.15 The voltage at J1 - Pin 9 shall be a positive pulse 200 mv ± 50 mv in amplitude at a 10 pps ± 1 pps rate.

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MFG. CODE NUMBER 13126

S40682

REVISIONS

LTR	EFF	SYM	DESCRIPTION	BY	DATE	CH'D	APPROVAL

S40682

REV														
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5 Feb 65

5 Feb 65

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TITLE

Ejecta Detector
(GSE - Surveyor
ML 260-1
Operational Manual

MARSHALL LABORATORIES

NO. S40682

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ML FORM 54

S40682

1.0 SCOPE

1.1 This specification contains a description of the functions and operation of the Surveyor Ejecta Detector GSE ML 260-1.

2.0 APPLICABLE DRAWINGS

2.1 Marshall Laboratories, 51287, Schematic Diagram Micrometeorite Ejecta Detector, (GSE - Surveyor)

2.2 Marshall Laboratories, 51444, Jacks-in-a-Box (Surveyor - GSE) ML 270-1.

3.0 FUNCTIONAL DESCRIPTION OF THE EJECTA DETECTOR GSE

3.1 The Ejecta Detector GSE is a portable test set which supplies all electrical power and signals necessary to check the Lunar Ejecta Detector ML 185-1 for proper operation. The test set provides a readout display instantaneously upon initiating the stimulus for the Lunar Ejecta Detector experiment. The operator now has a visual check of the experiment data correlated with the input parameters which are selected on the front panel.

In addition the Ejecta Detector GSE may be used in conjunction with the spacecraft to supply only experiment stimulus, while the spacecraft or simulator is to provide telemetry signals and readout display.

3.2 The Ejecta Detector GSE can be operated on an external 12-volt battery, or operated from 115-volt A.C. line. Terminals for the battery are located on the rear panel. To conserve power while in battery mode, panel lights may be turned off by use of a switch on the rear panel. This does not interfere with the readout display.

3.3 Specific functions of the Ejecta Detector GSE are to:

A. Provide spacecraft power to the experiment.

B. Provide heater power to the experiment.

C. Provide simulated sensor signals to the experiment.

D. Provide simulated telemetry signals:

1. CALIB command
2. CLEAR command
3. READOUT command

E. Provide storage of the serial binary readout data, binary to decimal conversion, and display.

F. Provide a monitor for the experiment temperature.

G. Provide a monitor for experiment power supply voltages.

H. Provide a monitor for experiment input current.

I. Provide monitor of all input and output signals of the experiment.

4.0 CABLING

4.1 There are five (5) cables supplied with the Ejecta Detector GSE which may be stored in the cable compartment located behind the rear panel.

4.2 Cable description:

A. Payload to GSE

B. Sensor to Payload

C. Sensor to GSE

D. A.C. Line Power

E. GSE to Jack Box

4.3 The sensor to payload and sensor to GSE cables are made of special high temperature cable.

4.4 A small shielded attenuator box is installed in the (sensor to GSE) cable to prevent any possible cross talk to other signal lines and provide optimum signal transmission levels.

4.5 The GSE to jack box cable was designed to not only relieve front panel congestion, but also to provide a means of disconnecting possible noise receiving cables when jacks are not in use.

4.6 Connectors on the rear panel of the GSE are designed to mate with only the proper cables to ensure intended interconnection.

5.0 DESCRIPTION OF GSE FRONT PANEL FUNCTIONS

5.1 The front panel controls provide simulation of all input parameters to the experiment. In addition there are tests designed to check the logic portion of the experiment.

5.2 The front panel may be divided into four groups, 1) readout display, 2) monitoring meter, 3) selection of input parameters with pushbutton switches, and 4) VERNIER/PRESET controls for sensor stimulus.

5.3 Pushbutton switches are lighted to indicate the selected input parameters.

5.4 Four pushbutton switches are used for indicating power modes.

A. POWER - GSE power on.

B. EXP POWER - experiment power on

C. BATTERY-LINE - GSE power supplied by 115V, 60 cycle A. C. or external D. C. battery

D. HEATER POWER - 22V power for experiment heater located in sensor housing.

5.5 The operational limits on the line voltage are from 105V to 122V, 60 cps A. C.

5.6 The operational limits on the battery mode are from 12.2V to 20V. The battery rating should be a minimum of 300 ma. Polarity must be observed on terminals when connecting external battery although fuse protection is provided in the event of battery polarity reversal.

5.7 To initiate any one of the three commands (CALIB, CLEAR, or READOUT) the REPEAT/MANUAL switch must be in the MANUAL position. The desired command is selected by depressing one of the three switches. Only one command is to be selected at a time. The lighted switch indicates which command has been selected. The lighted (ENTER COMMAND) switch is depressed momentarily to initiate command after the selection.

5.8 The calibrate command provides the in-flight calibration of the MIC PHA and FILM PHA mode of operation. In order to achieve a complete calibration, the CALIB command must be initiated twice. The sequence of the in-flight calibration alternates with every depression of the switch as follows:

FILM A PHA = 12
MIC PHA = 6

FILM B PHA = 6
MIC PHA = 2

The results of this command are immediately displayed by the GSE with the appropriate film identification and accumulator information.

5.9 The CLEAR command is also a simulated telemetry signal. This command is initiated to clear possible shorts that may have existed on the film plates. The Flight System's clear signal, causes a disturbance in the film amplifiers, which results in an erroneous readout.

5.10 The READOUT command is another simulated telemetry signal. This command starts the Flight System readout. The readout command function is used for repeating the readout of the most recent stored information. Repeated readout commands may be used to test the Flight System's susceptibility to noise by observation of the repeated data.

6.0 ANALOG SIGNALS

6.1 The analog signals are as follows:

A. MIC

B. FILM A

C. FILM B

6.2 The timing indicated on the switches will be referenced to the time of a pulse generated by the ENTER DATA switch. The ENTER DATA switch initiates the analog sequence.

6.3 The MIC analog pulses may be selected at T = 0 μ sec, T = 50 μ sec, T = 500 μ sec, T = 50 M sec, and T = 150 M sec.

6.4 To prevent a second MIC pulse from being generated during the pulse height analysis of the first pulse, the selection switches are appropriately interlocked, the left-most switch taking precedence.

6.5 With the selection of the MIC T = 0 μ sec, additional selections are as follows:

A. MIC T = 50 μ sec is not allowed

B. MIC T = 500 μ sec is not allowed

C. MIC T = 50 M sec generates a pulse during the readout of the MIC PHA bits. No pulse height analysis is made, however, one extra count is added to the MIC accumulator.

D. MIC T = 150 M sec generates a pulse after the MIC PHA and MIC ACC have been read out, and before the completion of the entire readout. No analysis is made. One extra count will be added to the accumulator on the next readout.

6.6 The FILM A, FILM B signals may be selected at T = 0 μ sec, T = 50 μ sec T = 500 μ sec, and T = 50 M sec.

6.7 With the selection of T = 0 μ sec, on FILM A or FILM B as a reference, additional selections are as follows:

A. FILM T = 50 μ sec is not allowed

B. FILM T = 500 μ sec is not allowed

C. FILM T = 50 M sec, no analysis is made, however, one extra count is added to the accumulator.

6.8 The T = 50 μ sec and T = 500 μ sec switches, both MIC and FILM, have other functions. For example, if a hit occurs on the MIC, the FILMS will accept information for 100 μ sec, then film analysis will be inhibited. until readout is completed. If a hit occurs on either film, the MIC PHA will be inhibited after 100 μ sec.

6.9 For a more detailed example refer to 9.0, Acceptance Test.

7.0 ANALOG SIGNAL MODES

7.1 The modes in which the analog signals may be generated are as follows:

A. REPEAT/MANUAL

B. PRESET/VERNIER

7.2 The REPEAT mode initiates the data at a rate of .5 cps.

7.3 In the MANUAL mode, the data is initiated by momentarily depressing the ENTER DATA switch.

7.4 In the PRESET mode, the PHA windows are selected by the use of a thumb wheel switch. The preset number on the switch should correspond to the displayed number in the PHA readout.

7.5 The VERNIER mode is used in tests to establish the threshold of the PHA windows.

7.6 The vernier potentiometers are calibrated in tens, hundreds, and thousands of millivolts. The largest output is ten volts. The FILM analog signals are calibrated to $\pm 1\%$ of the dial setting. Before calibrating a Flight System, the $28\overline{V}$ must be adjust for $28V \pm 1\%$.

7.7 The FILM HI-LOW toggle switch, located on the front panel, is used to acquire the desired dynamic range of the analog signal. In the LO position the first eleven (11) PHA steps are produced. In the HIGH position, steps twelve through fifteen are obtained.

7.8 The MIC analog signal is attenuated by a factor 62.1:1 from the MIC vernier setting.

7.9 Additional pulses to the MIC and FILM amplifiers are generated by the GSE other than those that are selected by the switches. Automatically pulses are generated during the MIC accumulator readout, and FILM accumulator readout. No PHA analysis is made, and no counts are added to the accumulators. These pulses are provided to check the inhibits of the accumulators during readout.

S40682

8.0 METER MONITOR

8.1 The meter provides a check of the following experiment parameters:

A. TEMP (of sensor unit in °C)

B. I_{PRI} (primary current)

C. 2V

D. 29V (actually 28V at the experiment)

E. 3V

F. 12V

G. 6V

H. -7V

I. I_{HTR} (sensor heater current)

8.2 The sensor temperature probe is located in the sensor blivet. The meter reads temperature directly in degrees centigrade.

8.3 I_{PRI} is the current drawn by the experiment. The meter reads milliamperes deviation from nominal.

8.4 The 2V B+ monitor is located in the power supply blivit. The meter reads the percentage change in volts from nominal (2.04V).

8.5 In the 29V position the meter indicates the D.C. voltage (from the spacecraft) applied to the experiment. The meter is calibrated to measure the percentage change from the nominal 28V.

8.6 The four (4) experiment power supply voltages -- 3V, 12V, 6V, and -7V, are displayed as percentage changes from nominal.

8.7 The I_{HTR} scale reads directly in milliamperes the current supplied to the heater in the sensor blivit.

9.0 ACCEPTANCE TEST

9.1 POWER ON
EXP POWER ON
LINE
REPEAT
PRESET

9.1.1 Depress all five (5) switches in MIKE row (upper row).

9.1.2 Rotate the MIC PRESET thumbwheel through all settings. At each setting note that the MIC PHA display corresponds to the setting except that an "8" on the wheel corresponds to a "0" on the display.

OBSERVE: FILM PHA = 00
FILM ACC = constant
ID = both at zero (0)

9.1.3 Note that the MIC ACC display advances three (3) counts per readout and cycles from 0 through 7 and back to 0.

OBSERVE: FILM PHA = 00
FILM ACC = constant
ID = both at zero (0)

9.1.4 Release the MIC 150 M sec switch and note that MIC ACC display advances two (2) counts at a time.

OBSERVE: FILM PHA = 00
FILM ACC = constant
ID = both at zero (0)

9.1.5 Release the MIC 50 M sec switch and observe that the MIC ACC display advances one (1) count at a time.

OBSERVE: FILM PHA = 00
FILM ACC = constant
ID = both at zero (0)

9.1.6 Release the three (3) remaining MIC switches and observe that all readings are constant.

9.2 POWER ON

EXP POWER ON

LINE

REPEAT

PRESET

9.2.1 Depress the four (4) FILM A switches and rotate the FILM PRESET thumbwheel through settings 0 through 15.

OBSERVE: The FILM PHA display will correspond to each setting on the wheel.

The FILM ACC display advances two (2) counts per readout.

The A-ID is at a 1, the B-ID is at a 0.

MIC PHA = 0

MIC ACC = constant

9.2.2 Release the FILM A 50 M sec switch. Note that now the FILM ACC advances one (1) count per readout. All other readings remain as in paragraph 9.2.1.

9.2.3 Release the remaining three (3) FILM A switches and observe that all readings are constant

MIC PHA = 0

B-ID = 0

9.2.4 Repeat paragraphs 9.2.1 through 9.2.3 replacing FILM A with FILM B.

9.3 POWER

LINE

EXP POWER

MANUAL

9.3.1 Depress CALIB switch and then momentarily (once) depress the ENTER COMMAND switch and observe sequence FILM A or FILM B. Momentarily depress the ENTER COMMAND switch and observe the other sequence. At each further depression of the ENTER COMMAND switch the display will alternate between FILM A and FILM B.

FILM A

FILM PHA = 12

FILM ACC = advances one (1) count

A-ID = 1

B-ID = 0

MIC PHA = 6

MIC ACC = advances one (1) count

FILM B

FILM PHA = 6

A-ID = 0

MIC PHA = 2

MIC ACC = advances one (1) count

FILM ACC = advances one (1) count

B-ID = 1

9.3.2 Release the CALIB switch and depress the CLEAR. Depress and release the ENTER COMMAND switch.

OBSERVE: Erroneous Readout

9.3.3 Release the CLEAR and depress the CALIB. Momentarily depress the ENTER COMMAND and observe sequence FILM A or FILM B. Release CALIB and depress READOUT switch. Momentarily depress the ENTER COMMAND switch and observe that each time the ENTER COMMAND switch is depressed, the display flickers and returns to its original reading (i.e., sequence FILM A or FILM B).

9.4 POWER

LINE

EXP POWER

REPEAT

PRESET

MIC PRESET = 5

FILM PRESET = 11

9.4.1 Set MIC 0 μsec switch and depress FILM A 0 μsec switch.

OBSERVE: FILM PHA = 11

FILM ACC = advances one (1) count per R/O

A-ID = 1

B-ID = 0

MIC PHA = 5

MIC ACC = advances 1/R/O

9.4.2 Release FILM A 0 μsec and repeat paragraph 9.4.1 with FILM A 50 μsec depressed, then release FILM A 50 μsec.

9.4.3 Depress FILM A 500 μsec.

OBSERVE: FILM PHA = 0

FILM ACC = advances one (1) count/R/O

A-ID = 0

B-ID = 0

MIC PHA = 5

MIC ACC = advances one (1) count/R/O

Release FILM A 500 μsec.

9.4.4 Depress FILM A 50 M sec and observe that the displays are as in paragraph 9.4.3.

Release FILM A 50 M sec

Release MIC 0 μsec

9.4.5 Depress MIC 50 μsec and FILM A 0 μsec.

OBSERVE: FILM PHA = 11
FILM ACC = advances one (1) count/R/O
A-ID = 1
B-ID = 0
MIC PHA = 5
MIC ACC = advances one (1) count/R/O

Release MIC 50 μsec

9.4.6 Depress MIC 500 μsec.

OBSERVE: FILM PHA = 11
FILM ACC = advances one (1) count/R/O
A-ID = 1
B-ID = 0
MIC PHA = 0
MIC ACC = advances one (1) count/R/O

Release MIC 500 μsec

9.4.7 Depress MIC 50 M sec and observe same display as in paragraph 9.4.6.

Release MIC 50 M sec

9.4.8 Depress MIC 150 M sec and observe same display as in paragraph 9.4.6.

Release MIC 150 M sec

9.4.9 Repeat paragraphs 9.4.1 through 9.4.9, replacing FILM A with FILM B in each step.

9.5 POWER ON

LINE

EXP POWER

REPEAT

PRESET

MIC PRESET 3

FILM PRESET 14

9.5.1 Depress FILM A 0 μsec and FILM B 50 μsec switches

OBSERVE: FILM PHA = 14

FILM ACC = advances one (1) count/R/O

A-ID = 1

B-ID = 0

MIC PHA = 0

MIC ACCUM = constant

Release FILM B 50 μsec

9.5.2 Depress FILM B 500 μsec

OBSERVE: FILM PHA = 14

FILM ACC = advances one (1) count/R/O

A-ID = 1

B-ID = 0

MIC PHA = 0

MIC ACCUM = constant

Release FILM B 500 μsec

9.5.3 Repeat paragraphs 9.5.1 and 9.5.2 interchanging FILM B and FILM A.

9.5.4 Repeat paragraphs 9.5.1 through 9.5.3, changing the FILM PRESET thumbwheel to one (1). All readings shall be the same except:

FILM PHA = 1

FILM ACC = advances two (2) counts/R/O

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MARSHALL LABORATORIES

IDENTIFYING NAME ELECTRONICS ASSY. - MICROMETEORITE EJECTA DETECTOR (SURVEYOR) MODEL ML 185-1

ISSUE DATE 11/6/64 REVISION DATE ______ EFFECTIVITY ______ SHEET 1 OF 3

LIST NO.	ASSEMBLY POSITION 1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
1	.									51117-101		Electronics Assy.
2		R								L50677		Layout
3		R								50678		Envelope
4		R								50685		Electrical Interface
5		R								51114		Schematic Diagram
6												
7		1								51122-101		Housing Assy. - Power Supply
8			1							T51210-101		Matrix Assy.
9				1						T51210-1		Matrix
10			1							T51215-101		Positioning Board
11				1						T51215-2		Hook-up Board
12			1							T51215-1		Support Board
13			2							T51214-1		Spacer - Matrix
14												
15			1							SP30245-1		Housing
16												
17			3							W4157X1		Module (Command I. F.)
18			9							W2131X7		Module (DPN)
19			4							W2031X7		Module (DN)
20			1							W4170X1		Module (SCO Driver)
21			5							W133X11		Module (IM)
22			1							W131X8		Module (IM)
23			2							W233X7		Module (I/S)
24			1							W4158X1		Module (Sure Start Clock)
25			1							W730X7		Module (AC Driver)
26			1							W4162X1		Module (Sync. Rect.)
27			1							W4163X1		Module (Full Wave Rect. & D[illegible]R)
28			1							W4070X2		Module (DC Volt. Conv.)
29			1							W416[illegible]X1		Module (+12 Volt Series Reg.)
30			1							W4165X1		Module (-77. Series Reg.)
31												
32			2							SP301[illegible]		[illegible]
33			2							SP301[illegible]		" "
34			1							S[illegible]175		[illegible]
35			1							SP 3[illegible]		[illegible]
36			1							[illegible]		[illegible]

[illegible] BY [illegible]

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LIST NO.	1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
37												
38		1								51237-101		Housing Assy. - Digital
39			1							T51212-101		Matrix Assy.
40				1						T51212-1		Matrix
41			1							T51213-101		Positioning Board
42				1						T51213-2		Hook-up Board
43			1							T51213-1		Support Board
44			[illegible]							T51214-1		Spacer - Matrix
45												
46												
47			1							SP30246-101		Housing (Sub Assy.)
48				1						SP30246-1		Housing
49												
50			1							W130X7		Module (SIM)
51			[illegible]							W133X7		Module (SIM)
52			[illegible]							W134X7		Module (SIM)
53			2							W131X8		Module (SIM)
54			[illegible]							W4154X1		Module (A)
55			1							W4155X1		Module (PA)
56			1							W4172X1		Module (Integrator)
57			2							W4176X1		Module (Detector)
58			1							W4159X1		Module (Gated Clock)
59			3							W4153X1		Module (Comp. Out)
60			3							W4152X1		Module (Comp. In.)
61			1							W[illegible]69X1		Module (Gain Of 2 Amp.)
62			1							W4163X1		Module (Inhibit & Hold)
63			1							W4167X1		Module (Detector)
64			3							W233X7		Module (I/S)
65			1							W4171X1		Module (Trigger)
66			[illegible]							W231X7		Module (DPN)
67			4							W2031X7		Module (DN)
68												
69		1								SP30247-1		Cover
70		1								SP30247-2		Cover
71		R								SP30253-1		Jig - Matrix
72												

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LIST NO.	1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
73												
74		R								51234-101		Thermal Unit
75			I							51234-1		Circuit Board Assy. - Power Supply
76				I						T51235-1		Circuit Board
77			I							51234-2		Circuit Board Assy. - Digital
78				I						T51236-1		Circuit Board
79			I							SP 30245-1		Housing
80			I							SP30246-1		Housing
81			I							SP30247-1		Cover
82			I							SP30247-2		Cover
83												
84												
85												
86												
87		R								S40072		Manufacturing Spec.
88		R								S40081		Assembly Spec.
89		R								S40091		Conformal Coating Spec.
90		R								S40092		Foaming Spec.
91		R								S40094		Matrix Spec.
92		R								S40120		Gold Plating Spec.
93		R								S40138		Wire & Ribbon Spec.
94		R								S40149		Bonding Spec.
95		R								S40244		Loctite Spec.
96		R								S40379		Spot-Pot Spec.
97		R								S40394		Glass-Bead Peening Spec.

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IDENTIFYING NAME MICROMETEORITE EJECTA DETECTOR (GSE - SURVEYOR) MODEL ML 260-1

ISSUE DATE 6 November 1964 REVISION DATE ______ EFFECTIVITY S/N 1 & Up SHEET 1 OF 6

LIST NO.	1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
1	I									51304-101		Micrometeorite Ejecta Detector Assy.
2		R								51287		Schematic Diagram
3												
4		R								S40533		Test Spec. for 51304-101
5												
6		I								51273-1		Support - Chassis
7		I								51278-2		Support - Chassis
8		I								51279-1		Bezel - Switch
9		I								51280		Front Panel
10		I								51281-1		Bezel, Light
11		I								51282-1		Escutcheon Plate
12										51284		Meter Panel
13												
14		I								51285-1		Chassis - Power Supply
15		I								51283		Engraving - Push Button Switch
16		I								51289-101		Term. Board Assy. - A/C Line Rectifier
17			I							51289-1		Term. Board
18												
19		I								51291		Engraving - Front Panel
20		I								51335-1		Plate - Support
21		I								51290		Engraving - Escutcheon Plate
22		I								51336-101		Cable - Tray Assy.
23			I							51336-1		Frame
24			I							51336-2		Cover
25		I								51337		Back Panel
26												
27		I								51327-101		Ckt. Brd. Assy. - Digital Readout & Commands
28			I							51311-101		Matrix Assy. " " "
29				R						F51311		Matrix A/W " " "
30			I							51312-101		Positioning Brd. Assy. " " "
31				I						51312-1		Positioning Brd. - Digital Readout & Commands
32				I						51312-2		Hook-up Brd. " " "
33					R					F51312		Pos/Hook-up Brd. A/W " " "
34			2							51313-1		Spacer A/W " " "
35				R						F51313		Spacer A/W " " "
36			R							JP 30253-5		Jig-Matrix

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LIST NO.	ASSY POS. 1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE			
37															
38		3								GW 130X7		Module (SIM)			
39			R							S40210		Test Spec. for GW130X7			
40		2								GW530X7		Module (INV.)			
41			R							S40222		Test Spec. for GW530X7			
42															
43		3								GW132X7		Module (Sim. S.T)			
44			R							S40458		Test Spec. for GW132X7			
45		6								GW233X7		Module (One Shot)			
46			R							S40319		Test Spec. for GW233X7			
47		2								GW2030X7		Module (Nand Logic Gate)			
48			R							S40279		Test Spec. for GW 2030X7			
49		2								GW730X7		Module (A/C Driver)			
50			R							S40175		Test Spec. for GW730X7			
51		4								GW133X7		Module (IM.R.T)			
52			R							S40358		Test Spec. for GW133X7			
53		16								GW134X7		Module (SIM.T)			
54			R							S40359		Test Spec. for GW 134X7			
55		3								GW4155X1		Module (P/A)			
56			R							S40316		Test Spec. for GW4155X1			
57		1								GW2031X7		Module (Dual Nand)			
58			R							S40176		Test Spec. for GW2031X7			
59		1								GW4158X1		Module (Sure Start Clock)			
60			R							S40329		Test Spec. for GW4158X1			
61		R								S40534		Test Spec. for 51327-101			
62															
63															
64		1								51328-101		Ckt. Board Assy. - Power Supply			
65			1							51292-101		Positioning " " " "			
66				1						51292-2		Positioning Board " "			
67				1						51292-1		Hook up Board " "			
68					R					T51292		Pos/H Hook-up Brd. A/W - Power Sply			
69			2							51306-1		Spacer " "			
70				R						T51306		Spacer A/W " "			
71															
72															

[illegible] BY R. Golden

MASTER DRAWING LIST

MARSHALL LABORATORIES

IDENTIFYING NAME MICROMETEORITE EJECTA DETECTOR (GSE - SURVEYOR) MODEL ML 260-1

ISSUE DATE 5 November 1964 REVISION DATE EFFECTIVITY S/N 1 & Up SHEET 3 OF 6

LIST NO.	1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
73			1							51305-101		Matrix Assy. - Power Supply
74				I						51305-1		Matrix - Power Supply
75					R					T51305		Matrix A/W - Power Supply
76			R							SP30253-4		JIG - Matrix
77												
78												
79			1							CW4213X1		Module (11V. Regulator)
80				R						S40441		Test Spec. for CW4213X1
81			1							CW4070X3		Module (DC/AC Converter)
82				R						S40463		Test Spec. for CW4070X3
83			2							CW4163X2		Module (Rect/Doubler)
84				R						S40459		Test Spec. for CW4163X2
85			2							CW4164X2		Module (22V Regulator)
86				R						S40462		Test Spec. for CW4164X2
87			1							SP30202		Transformer
88												
89			1							SP30279		Transformer
90												
91			R							S40535		Test Spec. for 51328-101
92												
93												
94		1								51326-101		Circuit Board Assy. - Sensor Stimulus
95			1							51323-101		Positioning Board Assy. " "
96				1						51323-2		Positioning Board " "
97			1							51323-1		Hook Up Board " "
98				R						T51323		Positioning/Hook up Board A/W
99			1							51324-101		Matrix Assy. - Sensor Stimulus
100				1						51324-1		Matrix " "
101					R					T51324		Matrix A/W " "
102			2							51325-1		Spacer " "
103										T51325		Spacer A/W " "
104												
105										SP30253-6		Jig - Matrix
106												
107												
108												

Prepared by R. Golden

MDL 51304

MASTER DRAWING LIST

MARSHALL LABORATORIES

IDENTIFYING NAME MICROMETEORITE EJECTA DETECTOR (GSE SURVEYOR) MODEL ML 260-1

ISSUE DATE 6 November 1964 REVISION DATE EFFECTIVITY S/N 1 & Up SHEET 4 OF 6

LIST NO.	ASSEMBLY POSITION 1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE			
109															
110			2							GW233x7		Module (One Shot)			
111				R						S40319		Test Spec. for GW233x7			
112			3							GW4212x1		Module (A/OR Logic Gate)			
113				R						S40142		Test Spec. for GW4212x1			
114			3							GW4211x1		Module (A/NOR Logic Gate)			
115				R						S40141		Test Spec. for GW4211x1			
116			[illegible]							GW4155x1		Module (C/A)			
117				R						S40216		Test Spec. for GW4155x1			
118			[illegible]							GW4216x1		Module (S/C Driver)			
119				R						S40419		Test Spec. for GW4216x1			
120			R							S40536		Test Spec. for 51326-101			
121															
122		1								51309-101		Ckt. Brd. Assy. - Nulling Potentiometer			
123			1							51310-101		Ckt. Brd. Nulling Potentiometer			
124				1						51310-1		Board Nulling Potentiometer			
125					R					T51310		Circuit Master - Nulling Potentiometer			
126															
127															
128		1								51307-101		Ckt. Brd. Assy. - Motor Driver & Probe			
129			1							51308-101		Ckt. Brd. - Motor Driver & Probe			
130				1						51308-1		Board - Motor Driver & Probe			
131					R					T51308		Circuit Master - Motor Driver & Probe			
132															
133															
134															
135		1								51332-101		Ckt. Brd. Assy. - SW. Intercon. Upper			
136			1							51332-1		Board - SW. Intercon. Upper			
137				R						T51332		Circuit Master - SW. Intercon. Upper			
138															
139															
140		1								51333-101		Ckt. Brd. Assy. [illegible]			
141			1							51333-1		Ckt. Board - SW. [illegible]			
142				R						T51333		Ckt. Master - SW. [illegible]			
143															
144															

[illegible] R. Golden

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MARSHALL LABORATORIES

IDENTIFYING NAME MICROMETEORITE EJECTA DETECTOR (CSE SURVEYOR) MODEL ML-260-1

ISSUE DATE 6 November 1964 REVISION DATE EFFECTIVITY S/N 1 & Up SHEET 5 OF 6

LIST NO.	ASSEMBLY POSITION 1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE			
145															
146		1								51321-102		Terminal Board Assy - Film			
147			1							51321-101		Terminal Board Assy - Film			
148				1						51321-1		Terminal Board - Film			
149															
150		1								51321-103		Terminal Board Assy - Mic.			
151			1							51321-101		Terminal Board Assy - Mic.			
152				1						51321-1		Terminal Board - Mic.			
153															
154															
155		1								SP30150-A-4-16-157		Spacer - Threaded			
156		1								SP30286-A-4-16-180-3/4		Spacer - Threaded			
157															
158		2								SP30263-1		Decimal Readout			
159		2								SP30263-7		Decimal Readout			
160															
161		2								SP30264-15		Decimal Readout			
162															
163															
164															
165		1								51340-102		Line "RF" Filter Assy.			
166			1							51340-101		Terminal Board			
167				1						51340-1		Board			
168			1							51340-2		Can			
169			3							SP30278		R. F. Choke			
170															
171															
1.															
173		1								51341-101		Term. Board Assy. - Tie Point			
174										51341-1		Term. Board - Tie Point			
175															
[illegible]															
177		1								SP30154-102		Cable			
178															
179															
180															

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MARSHALL LABORATORIES

IDENTIFYING NAME MICROMETEORITE EJECTA DETECTOR (GSE SURVEYOR) MODEL ML 260-1

ISSUE DATE 6 November 1964 REVISION DATE EFFECTIVITY S/N 1 & Up SHEET 6 OF 6

LIST NO.	ASSEMBLY POSITION 1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
181												
182		R								SP30105		Capacitor
183												
184		R								SP30061		Transistor
185												
186		R								SP30219		Transistor
187												
188												
189		R								SP30112		Header
190												
191												
192												
[illegible]3												
194		R								S40004		Manufacturing Spec.
195		R								S40081		Assembly Spec.
196		R								S40088		Potting Compound Spec.
197		R								S40091		Conformal Coating Spec.
198		R								S40093		Connector Potting Spec.
199		R								S40109		Conductive Epoxy Spec.
200		R								S40125		Solder Plating Spec.
201		R								S40138		Wire & Ribbon Spec.
202		R								S40149		Bonding Spec.
203		R								S40379		Spot Potting Spec.
204		R								S40396		Protective Finish Spec.
205												
206												
207												

[illegible] BY, P. Golden

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MARSHALL LABORATORIES

IDENTIFYING NAME SENSOR ASSY. - MICROMETEORITE EJECTA DETECTOR (SURVEYOR) MODEL ML 256-1

ISSUE DATE 6 Nov. 1964 REVISION DATE ________ EFFECTIVITY ________ SHEET 1 OF 2

LIST NO.	ASSEMBLY POSITION 1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
1	1									51259-101		Sensor Assy.
2		R								L50677		Layout
3		R								51270		Envelope
4		R								51114		Schematic Diagram
5												
6		1								51254-101		Sensor Electronics
7			1							SP30255-101		Housing (Sub-Assy.)
8				1						SP30255-1		Housing
9			1							SP30256-1		Cover
10			1							SP30256-2		Cover
11			1							T51225-101		Matrix Assy.
12				1						T51225-1		Matrix
13			1							T51226-102		Positioning Board
14				1						T51226-1		Support Board
15			1							T51226-101		Positioning Board
16				1						T51226-2		Hook-up Board
17			2							T51227-1		Spacer-Matrix
18			1							W4221X7		Module (Mic. Calib).
19			2							W4222X7		Module (Film Clear)
20			1							W4223X7		Module (Film Calib.)
21			1							W4223X8		Module (" ")
22			2							W4156X1		Module (Cap. Amp.) (Deleted)
23			2							W2131X9		Module (DPN)
24			1							W134X7		Module (BIM)
25			1							W233X7		Module (I/S)
26			1							W41[illegible]6X1		Module (Heater) (Deleted)
27			1							T51[illegible]33-1		Support Board
28			1							51247-101		Mic. Amp. Assy.
29				1						T51232-1		Hook-up Board
30				3						W4151X1		Module ([illegible] Level Amp.)
31				1						W4160X1		Module (Hi Level Amp.)
32				1						SP30252-1		Filter
33				1						T51246-1		Insulator
34				R						T51238-101		Mold Form
35			1							W4242-1		Module (Cap. Amp.)
36												

PREPARED BY R. C. [illegible]

[illegible] 51259

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MARSHALL LABORATORIES

IDENTIFYING NAME SENSOR ASSY. - MICROMETEORITE EJECTA DETECTOR (SURVEYOR) MODEL ML 256-1

ISSUE DATE 6 November 1964 REVISION DATE ____ EFFECTIVITY ____ SHEET 2 OF 2

LIST NO.	ASSEMBLY POSITION 1	2	3	4	5	6	7	8	9	DRAWING NUMBER	CHG. LTR.	DRAWING TITLE
3[illegible]												
3[illegible]	I									51258-1		Impact Plate
37	R									51258-2		Cap - Impact Plate
[illegible]										51255-1		Shield - Cable
[illegible]										[illegible]		Shield - Cable
42												
43												
[illegible]												
[illegible]												
[illegible]												
[illegible]												
[illegible]	R									51271-101		Thermal Unit
[illegible]		I								51271-1		Circuit Board Assy.
50			I							T51267-1		Circuit Board
51		I								51271-2		Circuit Board Assy.
52			I							T51268-1		Circuit Board
53		I								SP30255-101		Housing - (Sub-Assy.)
[illegible]			I							SP30255-1		Housing
55		I								SP30256-1		Cover
56		I								SP30256-2		Cover
57												
[illegible]												
[illegible]	R									S40072		Manufacturing Spec.
60	R									S4[illegible]031		Assembly Spec.
61	R									S40091		Conformal Coating Spec.
62	R									S40092		Foaming Spec.
63	R									S40109		Bonding Spec. (Conductive Epoxy)
64	R									S40118		Protective Finish Spec.
65	R									S40120		Cold Plating Spec.
66	R									S40138		Wire & Ribbon Spec.
67	R									S40[illegible]		Bonding Spec. (Epoxy)
68	R									S40094		Matrix Spec.
69	R									S40244		Loctite Spec.
70	R									S40379		Spot-Pot Spec.
71	R									S40394		Glass-[illegible] Potting Spec.
72												